the Nansen LEGACY

Seasonal cruise Q2 2021

Cruise Report

The Nansen Legacy Report Series 34/2022

Seasonal cruise Q2 2021

Cruise 2021704

R/V Kronprins Haakon
Tromsø-Longyearbyen
27 April – 20 May 2021

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To be cited as: Ludvigsen M, Assmy P, Adams MJS, Arumi MA, Bjørkelund TM, Bodur Y, Bremnes JE, Flo S, Gawinksi C, Giebichtenstein J, Halvorsen E, Hatlebakk M, Hess S, Hop H, Itkin P, Jones E, Karlsson K, Keck A, Kohlback D, Kohler SG, Krapp R, Leopold P, Marquardt M, Molina EJ, Nowicki R, Olsen LM, Ortiz GA, Petit T, Ricardo de Freitas T, Saubrekka K, Sen A, Steer A, Summers N, Thiele S, Thorstensen H, Vihtakari M (2022). Seaonsal cruise Q2 2021: Cruise report. *The Nansen Legacy Report Series* 34/2022. DOI: https://doi.org/10.7557/nlrs.6689

ISSN 2703-7525
Publisher: Septentrio Academic Publishing, Tromsø, Norway

Summary

The spring season was the target for the Nansen Legacy cruise organized in late April and first half of May 2021 following the transect defined for this series of cruises to capture the variations of the year sampling physical, biological and chemical conditions in the ice and the sea. The transect went through both open water and ice. Seven process stations were visited (P1 through P7) together with smaller NLEG stations according to the program for the seasonal investigations. The first station (P1) was in open waters, while the remaining six main station had ice coverage of varying degree. Each of the process stations lasted 24 hours or more to allow a full diurnal cycle. Sampling included ice physics, ice samples, phytoplankton, zooplankton, marine chemistry and eco toxicology using acoustic, optical and robotics methods together with lab analyses of physical samples. Remote sensing data were also matched with in situ observations of both sea and ice conditions.

The ice conditions varied from 10 -20 cm thick ice till ice more than a meter thick. The general pattern was that the ice thickness was increasing with latitude but with several exceptions. The operation was interdisciplinary covering all the research foci of the project together with technology development. As expected, we measured high values of chlorophyll in several stations indicating spring bloom conditions. In the southern stations, the stratification was weak – but more pronounced further north. Using the robotic vehicles, we could absorb high concentrations of ice algae on certain stations – but not all. With this cruise the seasonal investigations were concluded providing observations for all four main seasons of the year.

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1 Background

The Nansen Legacy seasonal Q2 cruise on RV Kronprins Haakon concluded the seasonal investigation of the northern Barents Sea and adjacent Arctic Basin. The cruise is a key milestone for 2019 – 2021 project period. The cruise addressed objectives of the research foci in RF1 on Physical drivers, RF2 on Human drivers and RF3 on the living Barents Sea together with RA-C Technology, and collected necessary data along the Nansen Legacy transect in open and ice-covered waters. Experiments were an important component of the research to quantify processes, rates and interactions that will also feed modelling work and projections in RF4. The ongoing establishment of routines for sampling, data management and data storing continued as part of the practical work onboard. Robotic vehicles were deployed both at the surface and underwater to increase our observation capabilities. A dive team participated in the cruise to collect under-ice samples. Many of the cruise participants were new PhD and post docs and realized the training of a new generation arctic scientists.

Prior to the cruise, a ten day long isolation period was carried out at the Malangen Brygger resort close to Tromsø and all participants were test for covid-19 infection prior to the isolation and after seven days to reduce the risk of bringing contagion onboard the research vessel. Based on experiences from the AeN Q1 cruise a risk assessment was develop for covid-19 related risks. During the isolation period, safety training both for ice work and for use of flotation suits was done.

The seven P-stations defined for the seasonal cruises were all visited and the sampling program completed. The Q2 cruise started investigations at the southernmost station P1 on April 29th and was completed on May 16th at the northernmost station P7. Between the P stations, shorter CTD stations (NLEG 1-25) were sampled for hydrographical and biogeochemical parameters to get a higher spatial resolution along the transect. Due to the development of the spring bloom north of Svalbard a series of shorter stations (NLEG A-D), including CTD casts and Bongonet hauls were added to the program on the transit from P7 to Longyearbyen.

The cruise departed from Tromsø on April 27th north bound. P1 was reached on April 29 starting with trawling and CTD before a series of nets were deployed for abundance measurements for phyto- and zooplankton, ecotoxicology, cultivation experiments, biogeochemical parameters, chlorophyll, trace metal sampling, and optical measurements for radiance and irradiance. A demersal trawl was completed before we reached the station. The profile showed Atlantic water masses and elevated fluorescence signals all the way down to 250 meters depth, it is expected that this is a result of vertical mixing caused by the storm we encountered upon arrival at P1. Both AUV and USV were deployed in partly clouded skies for turbidity and light measurements to be combined with remote sensing instrumentation. During the period on the station, a free-floating sediment trap was also deployed. The station was concluded with box core sampling.

P2 was reached on May 2nd, and the first observation of ice flows was made prior to arriving at the station. The ice was not sufficient to support an ice station, but a basket with two researchers was deployed at a small ice flow and ice cores were sampled. The vertical CTD profile showed elevated levels of chlorophyll down to approximately 70 meters depth. At 130 meters, we found a thermocline, but the water temperatures were below zero degrees Celsius all the way through the water column.

When we reached station P3 on May 3rd, the ice cover was denser, but it was still not possible to run a conventional ice station. Again, the crane was used with a basket to put researchers on the ice to do coring work and physical measurements. The CTD profile showed thermoclines and haloclines at 125 metres depth and a Chl-a level of 0.45 mg/m3 all the way down to this depth. The temperature at the seabed was 0.5C.

During the transit from station P3 to station P4, we experienced ice up to 1.5 meters thick, but arriving at the station, the ice was thinner and we spend some time to find an optimal floe thick enough to establish an ice station. In the open lead we were able to deploy the demersal trawl to collect amphipods, but surface ice reduced the value of the samples. On the P4 site, the sea ice reconnaissance team measured ice thickness from 10 cm up to 30 cm and the ice station was established for work on ice physics, robotics, coring, and diving. The ice was covered with ice algae. At this station, the thermocline was found at 100 meters depth, and the chlorophyll max of 1.2 mg/m3 at 20 meters depth. We left P4 on May 6th in the morning.

For P5 we were not able to do a complete ice station due to the presence of a polar bear. A proper ice reconnaissance was complete, and the holes for divers and underwater vehicles prepared. Two times the operation had to be aborted with personnel on the ice due to approaching polar bear. The ice thickness was 0.5 meters. A reduced program for ice core sampling was performed.

At station P6, the ice thickness was approximately 1 meter. The ice conditions were in general more open dominated with thinner ice with thicker floes between. The drift of the ice was high, up to 1 knot. The sediment trap was deployed before docking for ice work. The vessel was located close to a ridge to enable exploration of ice both from below and from the top and the station lasted for two days. The station appeared to be in a bloom condition with elevated values for fluorescence indicating higher chlorophyll content. At the ice measurements of ice physics, core sampling, hyperspectral measurements, net based sampling and diver samples were collected. At the end of the station, the ice cover drifted into warmer water. This caused the ice ridge on the site to partly disintegrate at the end of the period.

The final ice station was P7. A three-day ice station was planned. To be able to stay at the same ice floe for the entire period, we docked to the ice approximately 20 nautical miles to northwest of the P7 coordinates based on predicted ice drift and direction. A full ice station was completed including ice physics, cores, nets, dive samples, robotics and hyperspectral

measurements. This station was not in a bloom condition upon our arrival. Also, here we found both level ice and ridge conditions. However, the ridge appeared more consolidate – but the ice was still first year ice. During the period we drifted toward south east with speed 0.4 – 0.7 knots. A satellite fly over was planned to provide complementary data on the ice characteristics. At the end of the station, the fluorescence measurements indicated a subducted bloom trapped at the pycnocline at approximately 95 meters. In the final stages of the station work, we had drift approximately 20 nautical miles to south east and the final CTD profile showed elevated chlorophyll values also in the upper 30 meters indicating a surface bloom.

Table 1: CTD data for the stations

Station	**Date**	**Time**	**CTD**	**Depth**	**Ice thick**	**Seabed temp**	**Thermo-cline**	**Chl max (mg/m3)**	**Chl max depth (m)**
P1	29.04.	20:53	162	315	N/A	1.22	140	0.85	20
NLEG2	01.05.	13:32	168	315	N/A	1.4	220	1.7	120
NLEG3	01.05.	20:34	169	156	N/A	-0.1	110	1.0	20
P2	02.05.	00:44	170	189	N/A	-0.5	130	1.4	10
NLEG5	03.05.	04:36	173	196	N/A	-0.3	110	1.3	15
NLEG6	03.05.	09:45	174	181	N/A	-0.4	120	1.15	35
P3	03.05.	21:01	175	313	N/A	0.5	140	0.65	15
NLEG8	04.05	03:56	177	270	N/A	0.8	160	0.60	20
NLEG9	04.05	09:21	178	212		0.9	150	0.7	35
NLEG10	04.05	14:54	179	297		1.1	110	1.2	15
P4	04.05	18:19	180	352	0.2	0.7	100	1.2	20
NLEG12	07.05.	00:13	185	204		0.8	160	1.3	20
P5	07.05.	10:07	186	156	0.5?	0.5	N/A	0.62	15
NLEG14	08.05.	22:48	189	210		-0.2	110	0.42	40
NLEG15	09.05.	05:45	190	184		1.0	100	0.14	60

NLEG16	09.05.	07:05	191	177		1.6	100	0.35	35
NLEG17	09.05.	07:44	192	200		1.6	80	0.47	25
NLEG18	09.05.	08:20	193	275		1.5	70	0.55	30
NLEG19	09.05.	09:08	194	504		1.2	40	0.64	25
NLEG20	09.05.	12:16	196	-		-	70	2.95	35
P6	10.05.	13:48	198	922	1.0	0.0	85	1.55	20
NLEG22	12.05.	09:33	202	1551		-0.5	60	2.15	47
NLEG23	12.05.	14:01	203	1937		-0.65	80	1.27	20
NLEG24	12.05.	17:34	204	2800		-0.75	70	2.3	20
P7	13.05	16:30	206	3446	1.2	-0.72	90	0.49	20

2 Survey area

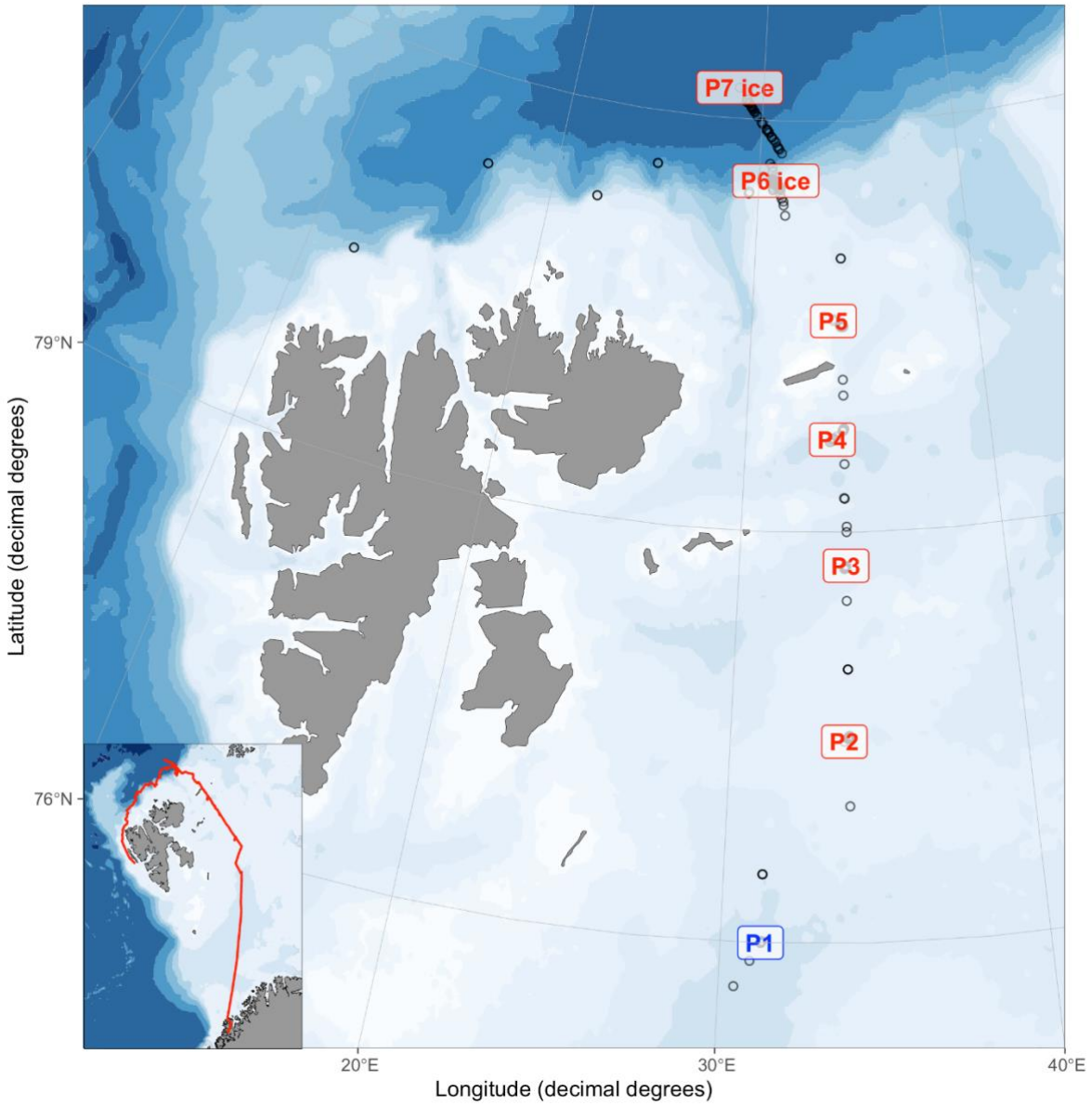


Figure 2.1: The Nansen Legacy transect with all process (P) stations sampled during the Q2 cruise. Insert showing the cruise track. Ice- and pelagic work was conducted on stations with red labels. The blue label indicates the Atlantic station P1 with only pelagic work. Black circles indicate sampling activities from the activity log. P7 and P6 were ice drift stations as indicated by the black circles. Station positions are taken from the first CTD cast for pelagic stations and from the logged start for ice stations. (Map made by Mikko Vihtakari, IMR)

3 Activity reports

3.1 Physics

3.1.1 Sea ice physical (RF1)

Adam Steer (NPI), Polona Itkin (UiT)

The sea ice physics program on the Nansen Legacy Q2 seasonal cruise in 2021 made observations at 6 of 7 Nansen Legacy P stations, alongside ASSIST shipborne ice observations while in transit through ice-covered waters. These were aimed at addressing tasks T1.1-1.2, and T1-2.2 – investigating the regional and local scale structure and variability of sea ice in the northern Barents Sea. The overall structure of the program was a multiple scale approach:

- Local/very high resolution: cores, snowpits, high resolution topographic reconstructions, ridge analyses, GNSS observations of ice drift and rotation
- Local/floe-scale: electromagnetic sounding of snow + ice thickness and snow probe surveys covering thousands of meters across a single floe along with connected ice areas (eg refrozen leads adjacent to a floe); deployment of autonomous ice mass balance buoys
- Regional-scale: ASSIST ice observations, coordination of high-resolution radar imagery from Radarsat-2 and TerraSAR-X which captures directly sampled sea ice

At each station the Nansen Legacy standard protocol for ice coring and basic snow description was completed. At P4, P5, P6 and P7 long transects with the GEM2 multi frequency electromagnetic induction sounder and Magnaprobe snow depth probe were conducted. At P4, P6 and P7 drone flights were undertaken with the aim of capturing local topography at high resolution, filling in gaps between the coarse GEM2 + Magnaprobe grids. At P4 a 'mini ridge' study was undertaken, collecting GEM2, Magnaprobe and snow micropenetrometer (SMP) observations across a small ridge (23m transect). At P6 and P7 this was expanded into a 40m and then 90m ridge transect, adding ridge structure estimation by noting changes as the observer drilled through the ridge at selected locations. Finally, at P7 a sea ice mass balance buoy was deployed on a ridge which was approximately 8m deep. The 5m thermistor chain in the ice is expected to observe the evolution of the ridge into spring and as it melts.

Each P station observed a different state of sea ice in the Northern Barents Sea – from marginal ice zone ice (e.g. pancakes, cemented pancakes at P2), then a thick snow covered ice floe with significant shares of rubble ice (P4 and P5), Arctic first year ice in the melting state by ocean heat (P6), and finally a typically 'Arctic' first year ice floe – over a meter thick with strongly consolidated ridges (P7).

3.1.1.1 Ice coring

The Nansen Legacy coring program was carried out at P3, P4, P5, P6 and P7. The RF1 chemistry team managed core collection and insitu processing, while the sea ice team handled salinity and O18 isotope subsampling. An additional 7cm core was collected at each site for density analysis.

3.1.1.2 GEM2 snow and ice thickness soundings

Preliminary snow and ice thickness profiles from electromagnetic sounding are given in Figure 3.1 for P4 to P7. Note the ice thickness increase as the cruise progressed from new, locally grown ice to older, thicker ice pushed southward by persistent northerly airflows.

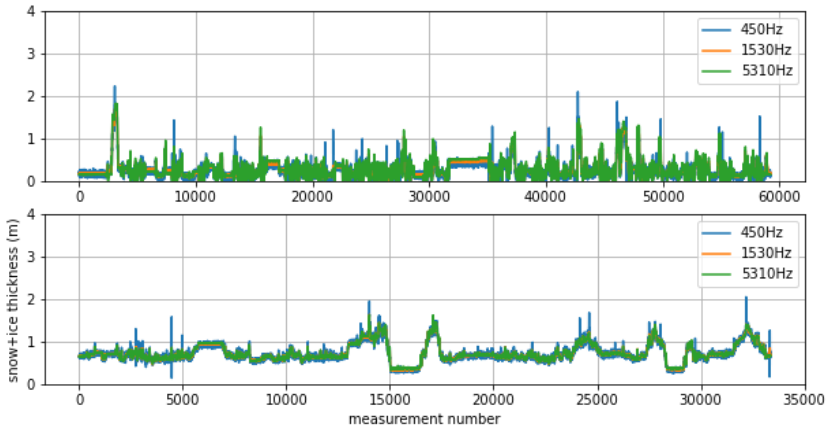


Figure 3.1: Snow and ice thickness observed by GEM2 soundings at P4 and P5

3.1.1.3 Snow depth observations using Magnaprobe

Snow depth PDFs from magnaprobe observations for P4-P7 are given in Figure 3.2. The broadening distribution of snow depth reflects an evolving snowpack.

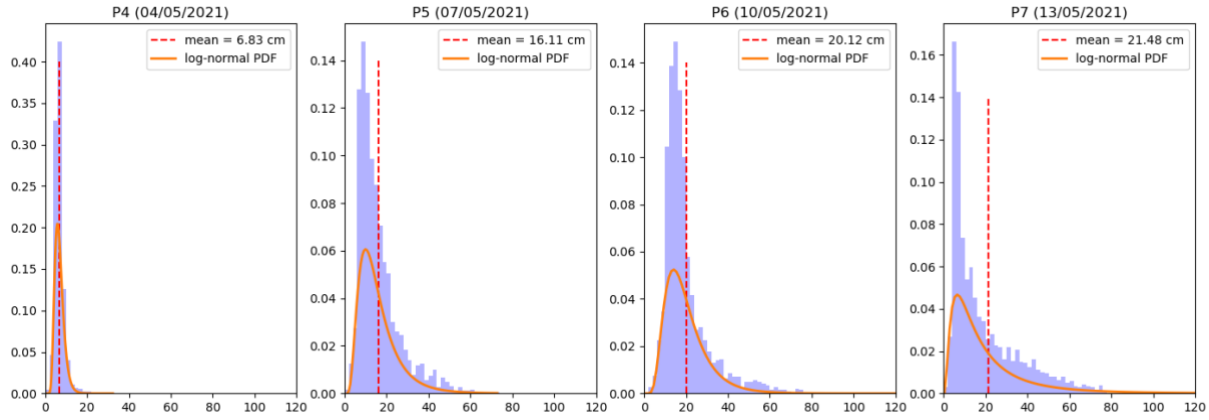


Figure 3.2: Magnaprobe snow depth distributions. Broader distributions indicate a developing snowpack with sastrugi, dunes, ridge deposits.

3.1.1.4 Snow observations

At P2, P3, P4, P5, P6 and P7 analytical snowpits were made on at least the main coring site. Depth, temperature profile, structure, density and salinity were measured. A small near-infrared camera was used to capture snowpit walls. At P4, P5 and P6 a snow

micropenetrometer (SMP) was used to collect snow hardness profiles around the main coring site. At P4 a mini ridge transect (23m) was sampled using the SMP.

At stations P3, P4, P6 and P7 we collected snow samples for analysis by micro-CT: snow structure and brine distribution within the snowpack.

Figure 3.3: SMP sampling (left) and snowpit (right)

Figure 3.4: collecting a 'snow core' for micro-CT analysis

3.1.1.5 Ridge transects

Longer ice stations and distribution of tasks allowed more intensive work around sea ice ridges. At P4, P6 and P7 GEM2 + magnaprobe surveys at 1m spacing were undertaken at progressively larger ridges (23m, 40m, and 90m respectively). Drill hole observations, attempting to gain a view of ridge internal structure, were also made along these transects.

Figure 3.5: direct sea ice thickness measurement along a ridge transect, collecting validation data for EM induction soundings

3.1.1.6 Aerial imagery using a small drone

Figure 3.6 shows a site map of P6 – the GEM2 and Magnaprobe observations cover this area in a coarse 'grid' capturing both level and ridged regions. This is an example product, which relies on an underlying 2.5D terrain model of the local region. The terrain model captures between 5 and 50cm detail, and will also contribute to structural analyses of ice floe morphology.

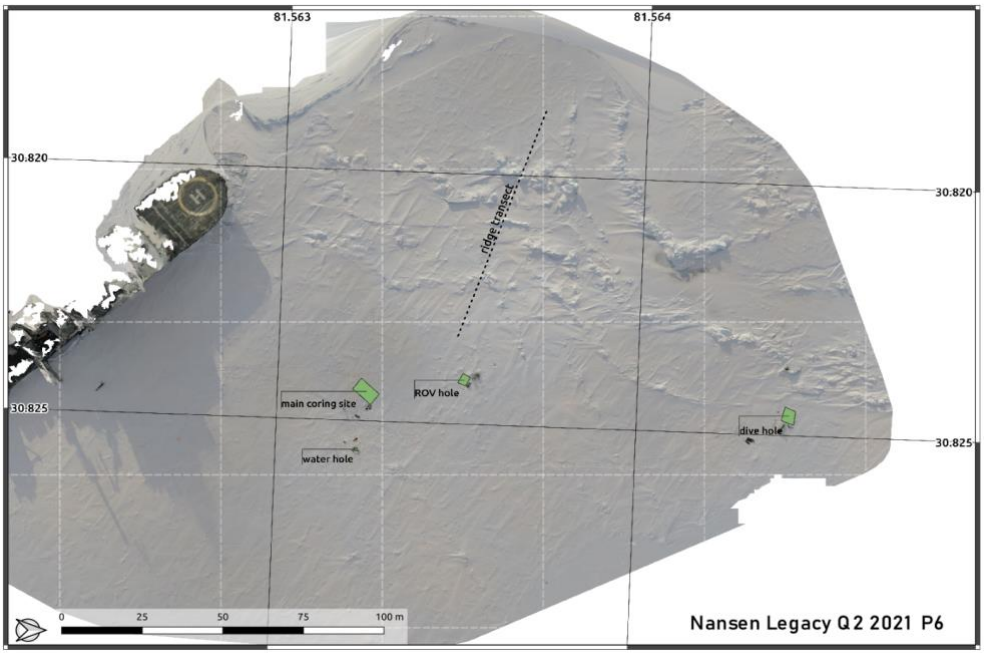


Figure 3.6: Orthophoto of ice station P6 showing layout and general site characteristics

3.1.1.7 Optical observations of the sea ice

Both pelagic and sea-ice optics observations were conducted during the cruise. See the dedicated optics section of the cruise report.

3.1.1.8 Sea ice chemistry

Detailed sea ice chemistry work is covered in a separate section of the cruise report.

3.1.1.9 ASSIST observations

A three hourly schedule was set up for ASSIST ship-based sea ice observations using the RF1 team and volunteers from the ships complement. Due to other work demands, an observation was not made at every scheduled slot. At ice stations, no observations were made because we would be resampling the same ice. There are no air temperature observations for most of the voyage because weather station instruments were being serviced off-ship. Later in the voyage we were shown another source of temperature and pressure data, however this information did not reach all observers.

3.1.1.10 High resolution radar imagery

Radarsat-2 images (30x30km , with ~5m horizontal resolution) were ordered for P4, P5 and P6. The orders were centered on the geographical coordinates of the stations and do not cover the ice floes sampled. Ice observations from the ship showed that for each station a wide region about each P station was relatively homogeneous, so the satellite scenes still represent comparable ice for the region.

Images from Radarsat-2 and TerraSAR-X were collected over P7 on 14 May 2021. This coincided with the ice station drifting through a small overlap in the footprint of both sensors.

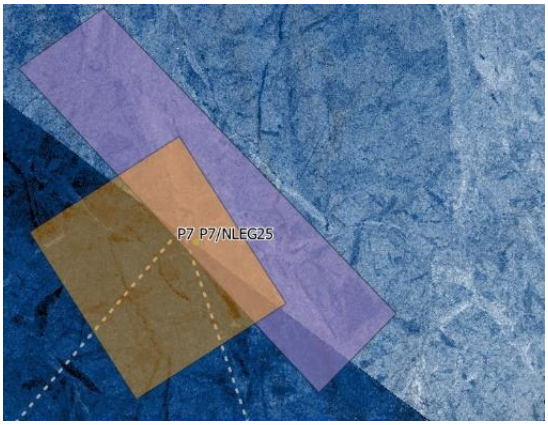


Figure 3.7: TerraSAR-X (orange) and Radarsat-2 image footprints over P7. Ice station P7 was within the overlap region a few kilometers south of the P7 location at capture time

3.1.1.11 Technical feedback

The sea ice physical processes team has components which are highly mobile and active on the sea ice. We found that the standard 'regatta suit' became a safety risk rather than

safeguard when undertaking high output physical activity (transects, snow removal, sled towing). The transect team were constantly wet in the field, more or less bathed in our own sweat. This presents a cascade of effects including refreezing of wet underlayers in the field, excess heat loss, and excess vapour from suit necks interfering with vision. A layering system with breathable outer shell is much preferred for this type of work.

Because we deploy primarily using the ship gangway, we would also like to see the to-ice gangway on FF Kronprins Haakon widened. This concern is echoed by the dive and underwater robotics team.

3.1.1.12 Summary

The 2021 Nansen Legacy Q2 seasonal cruise RF1 sea ice physical processes program was ambitious and only made possible by a dedicated, collaborative and enthusiastic team. It represents a rare combination of datasets covering very thin ice in the Barents Sea (P4) to thick, snow covered ice floes imported from the high Arctic (P6, P7). While there are some technical issues to resolve in future the team effort was extraordinary and well supported by voyage management and the sea ice safety team. We thank all involved in getting us to our field site and keeping us as safe as possible while we worked. We hope that the data collected will prove useful for all researchers in the Nansen Legacy and beyond.

3.1.2 RF1 T1-2.4: Light climate work

Tristan Petit (NPI/UiB), Adam Steer (NPI), Polona Itkin (UiT), Elizabeth Jones (IMR).

The main goal of the optics work was to collect Inherent Optical Properties (IOP) of the sea water and track their variability as function of depth and location. Two main IOPs are the absorption and scattering properties of the particulate and dissolved materials present in the water. IOPs are, by definition, independent of the characteristics of the light field occurring at time of data collection (as opposed to Apparent Optical Properties like downwelling irradiance). They can thus be used as proxies of several biophysical properties of the sea water (eg. phytoplankton concentration) as well as to model the Apparent Optical Properties (AOP, eg. the vertical structure of the downwelling spectral irradiance) of water for different light condition scenarios.

A second and more experimental survey aimed at collecting joint datasets of (i) under ice irradiance & ice transmittance properties and (ii) IOPs of sectioned ice cores and below ice water. Linked to this is a collaboration initiated between Tristan Petit (NPI) and Natalie Summers (NTNU) in the pre-cruise isolation time at Malangen. The idea is to build an “as exhaustive as possible” dataset of optical properties in and right below the ice for working together on the extraction of physical and biological as part of the AeN project.

3.1.2.1 Water IOP collection

First part of the water IOP measurements was conducted in-situ thanks to an optics cast from the side of the ship for performing high-resolution vertical profiles. A second part of the work involved water sampling and filtration for further analysis in lab of the samples taken at discrete depths along the in-situ vertical profiles. A total of 12 optics casts were performed from the side of the ship and 2 from the ice floe. Concomitant water samples could be collected for 9 of them. The work done at each station is represented by blue boxes in Table 2.

3.1.2.2 In-situ

In-situ data collection was performed thanks to an instrument package (

Figure 3.8) consisting of:

- A Wetlabs ac-s sensor capturing the absorption and attenuation (sum of absorption and scattering) of light by the sea water at 81 different narrow spectral channels in the visible range and with a sampling frequency of 4Hz. The ac-s used (s/n 311) has a 25cm optical path length making it suitable for clear water surveys.
- A Wetlabs Wetstar CDOM fluorometer sensor measuring the colour dissolved organic matter concentration with a sampling frequency of 1Hz.
- A Wetlabs Wetstar Chla fluorometer sensor (not calibrated) measuring the colour dissolved organic matter concentration with a sampling frequency of 1Hz.
- A Seabird SBE37SMP CTD (model with internal pump) measuring temperature, salinity and depth at a sampling frequency of ~0.6Hz.
- A Seabird 5T 3000RPM pump assuring the water flow through the ac-s sensors.
- A 51Ah 15V battery pack
- A Wetlabs DH-4 data logger powered by the battery pack. It was used for powering all the other components, collecting the data from the different sensors and storing them along a single time reference.

For each profile, the cast was first immersed and kept at 20m depth for 3 minutes to debubble the plumbing. It was then brought back to subsurface before performing the profile at a constant vertical speed of 0.4 m/s. The profiles were done between 0-350m depth when possible or by keeping a ~10% safety margin to the bottom when shallower.

The main plumbing and the CTD cells were rinsed with fresh water after each cast. The Ac-s optics and chambers were cleaned successively with soap, ethanol and Milli-Q water once a day. Ac-s blanks were measured 3 times during cruise with Milli-Q water alternatively injected inside each chamber thanks to a Peristaltic pump.

Figure 3.8: Deployment of the optics cast from the CTD hangar of RV Kronprins Haakon

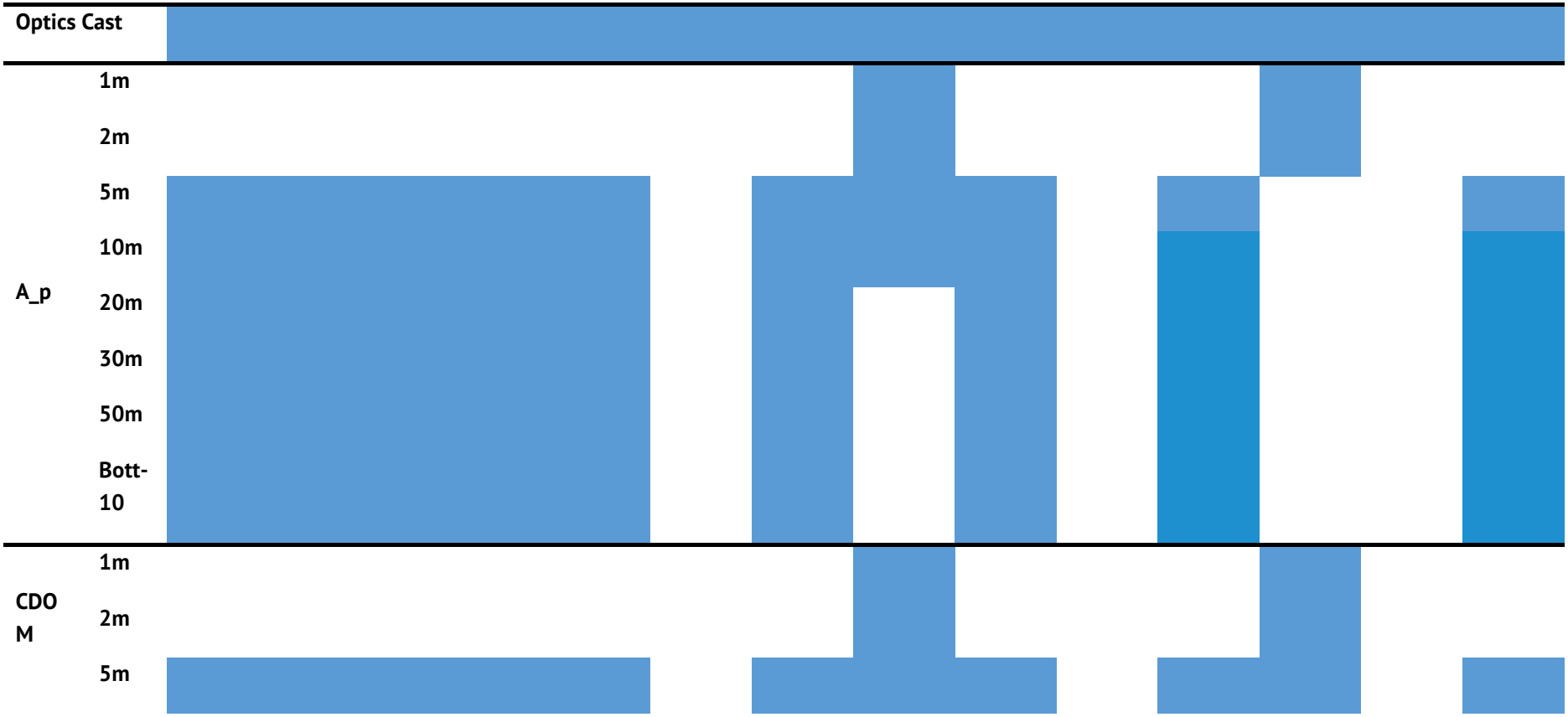
3.1.2.3 Discrete samples

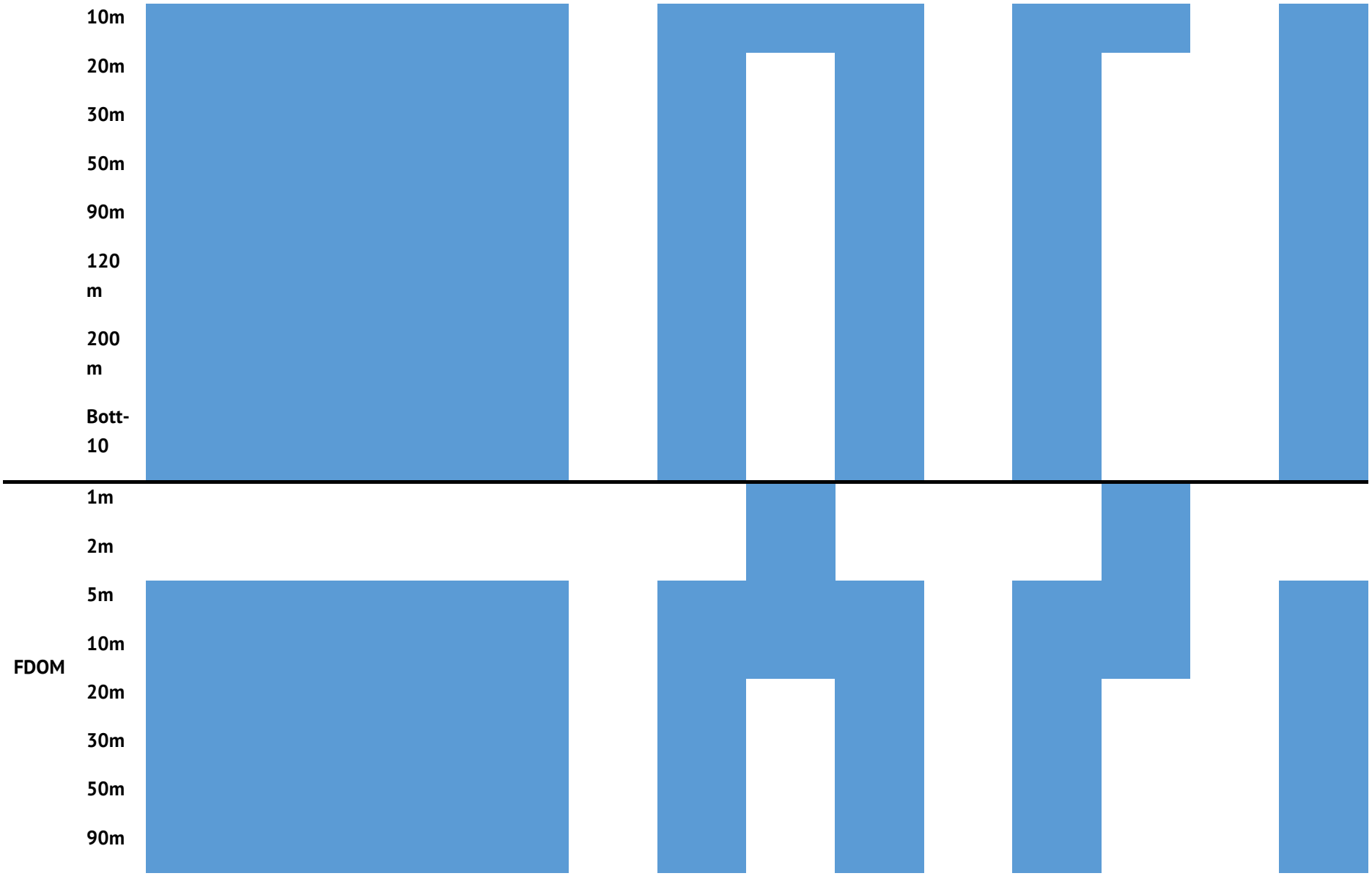
Two different kind of water samples were collected:

- Total/algal/mineral particulate absorption samples were collected at each process and filtered onto 25mm GF/F filters. The filtered volume was adjusted depending on the quantity of particles on the filters. The filters were flash frozen into liquid nitrogen before being placed into a -80^{o}C freezer. These samples are meant to be analysed inside an integrating cavity at HZG (Germany) with the help of Dr. Rüdiger Röttgers.
- Water samples for CDOM an FDOM were collected through prerinsed 0.2 µm Millipore Opticap XL filter capsules by gravity. The samples were stored in pre-combusted amber glass vials in dark at +4 °C. The CDOM samples are going to be analyse by Tristan at the University of Bergen while the FDOM samples will be sent to IOPAN in Poland.

Table 2 – Pelagic optics work done at the different stations. Achieved work is represented by boxes filled in blue.

Stat. no	P1	NLEG2	P2	NLEG5	P3	NLEG9	P4	P4ice	P5	NLEG14	P6	P6ice	NLEG24	P7
Lat (deg N)	76	76.4999	77.4983	77.9997	78.7352	79.2454	79.6847	79.6607	80.5037	81.0001	81.5445	81.5626	81.6600	82.0871
Lon (deg E)	31.22	31.2184	33.9885	33.9994	33.9505	33.9849	33.5566	33.4194	33.9243	33.9936	30.7792	30.8294	30.6454	29.4189

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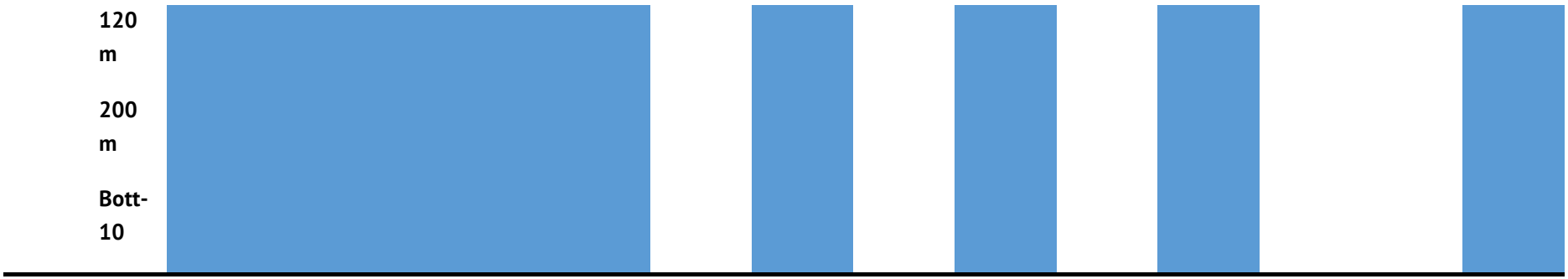
90m
FDOM


120 m
200 m
Bott-10

3.2 Microbiology

3.2.1 RF3 T3-1 and T3-4 Microbes: biodiversity, abundance, biomass, distribution and activity.

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The activity contributes to tasks T3-1 and T3-2 and links to T3-3 and T3-4. Samples for microbial (viruses, prokaryotes and protists) community composition, abundance and activity were collected from one open water stations (P1) and six ice covered stations (P2, P3, P4, P5, P6 and P7). A reduced sampling effort was conducted at the station P3. Pelagic samples were collected at all stations, while stations P4, P6 and P7 also included ice samples (ice-cores and under ice water and diving samples). In addition, flow cytometry samples were taken for the standard depths at several NLEG stations (NLEG2, NLEG3, NLEG5, NLEG6, NLEG8, NLEG10, NLEG12, NLEG14, NLEG15, NLEG16, NLEG17, NLEG18, NLEG19, NLEG20, NLEG22, NLEG23, NLEG24, NLEG-A, NLEG-B, NLEG-C, NLEG-D). Sampling also included phytoplankton nets. Chl *a* and live protist samples were analysed on board, while all other samples were preserved or frozen for later analyses. On board experiments included a grazer exclusion experiment. These were done at stations P1, P4 and P6, prepared by gentle reverse filtration of surface water from 20m to retain organisms of different size fractions (<0.8µm; <3µm; <90µm) and were incubated each for six days with additional nutrient and copepod treatments at *in situ* temperature and light. Subsamples for abundance and diversity analyses were collected at different frequencies throughout the incubation period.

Several functional aspects of pelagic and sympagic primary producers were studied during the Nansen Legacy Q2 cruise. At stations P1, P4, P5, P6 and P7, water was sampled from the standard depths 10, 20, 30, 40, 60, 90 and spiked with radioactively labeled carbon in order to determine the carbon fixation rate (i.e. the primary production rate) of phototrophic organisms. Additionally, water from 10m and 20m was spiked with stable isotopes of Carbon (13C) and Nitrogen (15N) to estimate the F-ratio (which fraction of the primary production is new production). One incubation bottle was also treated to assess the nitrification activity of microbes. This water was incubated in situ for 24 hours, attached to the sediment traps or from an ice hole (P4). The mooring was not recovered at P1. In parallel, water from 10m was used to study the photosynthetic response of the community to light intensity (P vs I curves). At the ice-covered stations (P4, P6 and P7), the bottom 3cm of 4 ice cores were sampled and pooled for similar incubations: under-ice primary production and nitrogen uptake in situ, P vs I curves. In addition, one ice core was collected at P6 and P7. The brine from the bottom 10 cm was analyzed with a spectroradiometer, to assess the absorption spectra of ice algal pigments.

The aim of sampling during the Nansen Legacy Q2 cruise was to assess the spring bloom condition of microalgae (phytoplankton and under ice algae). Water samples were taken at the open water stations P1, P2, P3, and at NLEG A to NLEG D at 10m and Chla max depth (or 20m using) the CTD. At P7, a sample was taken from the deep chl a max at 95m. Photosynthetic parameters were measures using Pulse Amplitude Modulated fluorometer (PhytoPAM), that measures fluorescence output at increasing light intensities. Water was also filtered through GFF filters then frozen in -80C freezer to bring back to Trondheim where pigment analysis will be conducted using HPLC. Additional water samples were fixed in Glutaraldehyde to be analysed in Southampton using automated flow cytometry (CytoSense) to look at trait variability of phytoplankton cells. The same protocols were used at the ice stations P4ice, P6ice and P7ice with under ice water from the water hole (0.5m deep) and with under ice samples taken by the divers via slurp gun or syringes. At stations P4ice, P6ice and P7ice, the bottom 3cm of ice cores were melted in 300mL of seawater and similarly processed.

Additionally, three ice cores (0-30cm) were sampled at P4ice, P5ice, P6ice and P7ice for investigation of sea ice meiofauna (sympagic meiofauna) abundance and biodiversity. Some of the ice core sections were investigated on board and couple of ice meiofauna were found especially at P4, P5 and P6, taxa such as Rotifers, Copepod nauplii, harpacticoid copepods). Further, slurp gun diving samples were scanned for ice meiofauna with similar results.

Sampling for protist and prokaryote community compositions (DNA metabarcoding) and activities (metatranscriptomics) was conducted as on previous cruises. At ice-stations (P4, P6 and P7) additional samples for metabarcoding were taken from under-ice water (UIW, 0.5 m), ice-core sections (biobulk) and from slurp gun diving samples taken at ice flats and ridges. In addition, stations NLEG-A, NLEG-B, NLEG-C, NLEG-D were sampled.

Additionally, a syringe sample of the top 1 cm of the sediment was obtained from the box cores at stations P1, P4 and P6. The sediment was suspended in filtered sea water and distributed in tissue culture flasks. The flasks were incubated under a 14:10 Light-darkness regime, and triplicates were fixed in glutaraldehyde-lugol after 12, 24 and 48 hours.

List of parameters sampled:

Biodiversity

- Genetic identification of community composition of protists and prokaryotes (Metabarcoding)
- Genetic identification of (free) virus diversity (Virus diversity)
- Qualitative analyses of protists >10 µm from net hauls (Net)
- Qualitative analyses of small protists for cultures

- Qualitative and quantitative analysis of plankton including coccolithophores by scanning electron microscopy (SEM)
- Algal diversity by culturing (Cultures)
- Biodiversity of ice meiofauna (Barcoding)
- Chemotaxonomy (HPLC pigment analysis)
- Microalgae trait variability (flow cytometry)

Abundance and biomass

- Algal biomass (total and >10 µm chlorophyll a concentration Chl *a*)
- Abundance of bacteria, virus, pico and nano-plankton by flow cytometry (FCM)
- Quantitative analyses of protists from water samples by light microscopy (Microscopy)
- Particulate organic carbon and nitrogen (POC/PON)
- Elemental composition of seston (XRF, particulate C:N:Si:Ca:P:Mg:S:K:Fe)(XRF)
- Abundance of ice meiofauna

Activity

- Genetic identification of protist activities (Metatranscriptome)
- Bacterial production
- Primary production
- Nitrogen uptake by primary producers (Nitrogen uptake)
- Primary producer's response to light intensity (P vs I curve)
- Microalgae photosynthesis (Rapid light curves)

Table 3: Water column and ice sampling for microbes (see text above for abbreviations).

Stn	Depth (m)	Metabarcoding	Virus diversity	Phytoplankton net	Vivaflow	SEM	Cultures	Chl. *a*	FCM	Microscopy	POC/PON	XRF	Metatranscriptome	Bacterial production	Primary production	Nitrogen uptake	P vs. I curve	Ice meiofauna	Rapid Light curves, Flow cytometry and HPLC
P1																			
	10	x				x		x	x	x	x	x	x	x	x	x	x		x
	20	x	x			x	x	x	x	X	x	x		x	x	x			x
	30							x	x	x	x	x		x					
	40							x	x		x	x		x	x				

	50							x	x		x	x		x					
	60							x	x	x	x	x		x	x				
	90							x	x	x	x	x		x	x				
	120							x	x		x	x		x					
	200	x				x		x	x		x	x		x					
	bottom	x	x			x		x	x		x	x		x					
	0-50			x			x			X									
P2																			
	10	x				x		x	x	x	x	x	x	x	x	x	x		x
	20	x	x			x	X	x	x	X	x	x		x					x
	30							x	x	x	x	x		x					
	40							x	x		x	x		x					
	50							x	x	x	x	x		x					
	60							x	x	x	x	x		x					
	90							x	x	x	x	x		x					
	120							x	x		x	x		x					
	bottom	x	x			x		x	x		x	x		x					
	0-50			x			x			x									
P3																			
	10	x				xx		x	x	x	x	x		x					x
	20	x				x	X	x	x	x	x	x		x					x
	30							x	x	x	x	x		x					
	40							x	x		x	x		x					
	50							x	x		x	x		x					
	60							x	x	x	x	x		x					
	90							x	x	x	x	x		x					

	120							x	x		x	x		x					
	200	x				x		x	x		x	x		x					
	bottom	x				x		x	x		x	x		x					
	0-50			x			x			x									
P4																			
	10	x				x		x	x	x	x	x	x	x	x	x			
	20	x	x			x	X	x	x		x	x		x	x	x	x		
	30							x	x	x	x	x		x					
	40							x	x		x	x		x	x				
	50							x	x		x	x		x					
	60							x	x	x	x	x		x					
	90							x	x	x	x	x		x	x				
	120							x	x		x	x		x					
	150																		
	200	x				x		x	x		x	x		x					
	bottom	x	x			x		x	x		x	x		x					
	0-50			x			x			x									
P5																			
	10	x				x		x	x	x	x	x	x	x	x	x			
	20	x	x			x	x	x	x	x	x	x		x	x	x	x		
	30							x	x	x	x	x		x					
	40							x	x		x	x		x	x				
	50							x	x		x	x		x					
	60							x	x	x	x	x		x					
	90							x	x	x	x	x		x	x				
	120							x	x		x	x		x					

	bottom	x	x			x		x	x		x	x		x					
	0-100			x			x			x									
P6																			
	10	x				x		x	x	x	x	x	x	x	x	x			
	20	x	x			x		x	x	x	x	x		x	x	x	x		
	30							x	x	x	x	x		x					
	40							x	x		x	x		x	x				
	50							x	x		x	x		x					
	60							x	x	x	x	x		x					
	90							x	x	x	x	x		x	x				
	120							x	x		x	x		x					
	200	x				x		x	x		x	x		x					
	500		x					x	x		x	x		x					
	750							x	x		x	x		x					
	bottom	x	x			x		x	x		x	x		x					
	0-100			x			x			x									
P7																			
	10	x				x		x	x	x	x	x	x	x	x	x			
	20	x				x	x	x	x	x	x	x		x	x	x	x		
	30							x	x	x	x	x		x					
	40							x	x		x	x		x	x				
	50							x			x	x							
	60							x	x	x	x	x		x					
	90		x					x	x	x	x	x		x	x				x
	120							x	x		x	x		x					
	200	x				x		x	x		x	x		x					

	500							x	x		x	x		x					
	750																		
	1000		x					x	x		x	x		x					
	1500								x		x	x		x					
	1750																		
	2000								x		x	x		x					
	2500							x	x		x	x		x					
	bottom	x	x			x		x	x		x	x		x					
	0-100			x			x			x									
P4ice																			
	0-3	x						x	x	x	x			x	x	x	x	x	x
	3-10	x						x	x	x	x			x				x	
	10-20	x						x	x	x	x			x				x	
	20-30	x						x	x	x	x			x				x	
	0-10		x			x	x			x		x							
	UIW 0.5	x				x	x	x	x	x	x	x		x					x
	UIW 0-5			X			X			x									
	SLURP	x				x	x												x
P5ice																			
	0-3																	X	
	3-10							X										X	
	10-20							X										X	
	20-30							x										x	
P6ice																			
	0-3	x						x	x	x	x			x	x	x	x	x	x

	3-10	x						x	x	x	x			x				x	
	10-20	x						x	x	x	x			x				x	
	20-30	x						x	x	x	x			x				x	
	30-50	x						x	x	x	x			x					
	50-70	x																	
	70-90	x																	
	90-top	x																	
	0-10		x			x	X		x	x	x	x		x					
	UIW 0.5	x				x	X	x	x	x		x		x					x
	UIW 0-5			X			X			x									
	SLURP	x				x	x												x
P7ice																			
	0-3	x						x	x	x	x			x	x	x	x	x	x
	3-10	x						x	x	x	x			x				x	
	10-20	x						x	x	x	x			x				x	
	20-30	x						x	x	x	x			x				x	
	30-50	x						x	x	x	x			x					
	50-70	x																	
	70-90	x																	
	90-top	x																	
	0-10		x			x	X			x		x							
	UIW 0.5	x				x	X	x	x	x	x	x		x					x
	UIW 0-5			X			X			x									
	SLURP	x				x													x

3.2.1.1 Sea ice work

Sea ice samples for biology were collected at the following stations; P4ice, P6ice and P7ice. Sea ice thickness at the three stations varied between 20 cm (P4ice) and 130cm (P7ice). Additionally at P5ice 3 ice cores were collected for ice meiofauna, ice algae taxonomy and chlorophyll a.

Sampling included ice-cores and water from under the ice (0.5m depth, sampled through a hole in the ice). In addition, a handheld phytoplankton net was used to collect samples from under ice (5-0m depth). A CTD profile was obtained from under the ice using a handheld RBR CTD equipped with fluorescence sensor and light sensor.

Table 4 shows an overview of which samples were collected (number of ice cores). Bio bulk samples were cut into sections which were pooled, and divided into sub-samples for metabarcoding, flow cytometry, chlorophyll *a*, POC/PON and bacterial production.

Table 4: Number and purpose of ice cores and under-ice water samples

	P4_ice	P5_ice	P6_ice	P7_ice
Ice-cores				
Chemistry 1	1	1	1	1
Chemistry 2	1	1	1	1
Physic (salinity)	1	1	1	1
Physic (stratigraphy)	1	1	1	1
Physic (density – 7cm kovacs)	1	1	1	1
Physic (Archive)	1	1	1	1
P versus I	2		2	2
Primary production	2		2	2
Bio bulk	5		5	5
Phytoplankton experiment	1		1	1
Ice-algae taxonomy	1		1	1
Meiofauna/algae	3	3	3	3
SEM	1		1	1

XRF	3		3	3
Virus	3		3	3
Nutrients/sal (bio)	1		1	1
Photosynthesis	3		3	3
HBI	2		2	2
fatty acids/stable isotopes/HBI	2		2	2
DOM/trace metals/mercury	5		4	5
Coccolithophores		1		
Foraminifera				2
Under ice water (0.5m depth)				
nutrients				
bio bulk	x		x	x
primary production	x		x	x
phytoplankton taxonomy	x		x	x
XRF	x		x	x
SEM	x		x	x
DOM/trace metals	x		x	x
coccolithophore diversity	x		x	x
Photosynthesis	x		x	x
Stable isotopes	x		x	x
phytoplankton net (5-0m)	x		x	x

3.2.2 RF3 T3-1.1 & 2.1: Mesozooplankton taxonomy, abundance, biomass and genomics

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3.2.2.1 Purpose

The main objective was to describe the mesozooplankton taxonomic composition, abundance and biomass along the transect going from open Atlantic water (P1) to ice covered Arctic water (P7). We expect to see a gradient in the presence of Atlantic and Arctic species.

The data obtained during this cruise (Q2) are part of the seasonal investigation of zooplankton communities with data collected in Aug 2019 (Q3), December 2019 (Q4) and March 2021 (Q1).

3.2.2.2 Description of work

We have sampled with Multinet Midi (HydroBios, opening: 0.25m^2, net length: 250 cm) and Bongonets (HydroBios, opening: 2 x 0.2827m^2, net lengths: 250 cm): For both nets we have been using both 180 µm and 64 µm mesh nets in order to cover all size groups. We refer to the samples from the two mesh sizes as "mesozooplankton" and "small mesozooplankton" respectively.

Taxonomy and abundance were sampled at 5 standard depth intervals using the Multinet. The depth intervals were from the bottom-200, 200-100, 100-50, 50-20 and 20-0 m. At the deep stations, the sampling depths were from 1000-600, 600-200, 200-50, 50-20 and 20-0 m. All samples were preserved in 4 % formaldehyde free from acid.

Total biomass (dry weight) and metabarcoding were sampled using Bongonets from the bottom-surface and from 1000 m to the surface at the deep stations. Each Bongonet were split in two, net 1 was used for metabarcoding and taxonomy with ½ of the sample for each. Net 2 was used for biomass and fatty acid. The biomass samples were dried and measured onboard. Genetic samples for metabarcoding was preserved in ice cold 96 % ethanol. Taxonomy samples were stained with Neutral red and preserved in 4 % buffered formaldehyde in order to distinguish between dead and alive specimens. The taxonomy samples will be used to support the metabarcoding samples.

Gelatinous zooplankton were picked out from MIK net at all stations except for P2. One picture was taken of each taxa including all individuals. Individuals in good conditions were weighted, photographed and stored individually with ice cold 96 % ethanol.

Table 5: Overview of mesozooplankton sampling

Purpose	Gear	Station	N samples	Task
Mesozooplankton taxonomy	Multinet 180 µm	P1, P2, P3, P4, P5, P6, P7	35	T3-1.1 & 1.2 T3-2.1 & 2.2
Small mesozooplankton taxonomy	Multinet 64 µm	P1, P2, P3, P4, P5, P6, P7	35	T3-1.1 & 1.2 T3-2.1 & 2.2
Mesozooplankton biomass	Bongonet 180 µm	P1, P2, P3, P4, P5, P6, P7	7	T3-1.1 & 1.2 T3-2.1 & 2.2
Small mesozooplankton biomass	Bongonet 64 µm	P1, P2, P4, P5, P6, P7	7	T3-1.1 & 1.2 T3-2.1 & 2.2
Mesozooplankton metabarcoding	Bongonet 180 µm	P1, P2, P3, P4, P5, P6, P7	7	T3-1.1
Small mesozooplankton metabarcoding	Bongonet 64 µm	P1, P2, P3, P4, P5, P6, P7	7	T3-1.1
Mesozooplankton taxonomy (alive/dead)	Bongonet 180 µm	P1, P2, P3, P4, P5, P6, P7	7	T3-1.1 & 1.2 T3-2.1 & 2.2
Small mesozooplankton taxonomy (alive/dead)	Bongonet 64 µm	P1, P2, P3, P4, P5, P6, P7	7	T3-1.1 & 1.2 T3-2.1 & 2.2
Mesozooplankton fatty acid (total community)	Bongonet 180 µm	P3, P4, P5, P6, P7	7	T3-1.1 & 1.2 T3-2.1 & 2.2
Gelatinous zooplankton	MIK net 1500 µm,	P1, P3, P4, P5, P6, P7	110 ind.	T3-1.1 & 1.2 T3-2.1 & 2.2

Table 6: Overview of gear deployment

Gear	Sampling depth		Hauling speed (m/s)	
	Shallow	Deep	lowering	heaving

Multinet 180 µm	Bot-200-100-50-20-0m	Bot-600-50-20-0m	0.5	0.5
Multinet 64 µm	Bot-200-100-50-20-0m	Bot-600-50-20-0m	0.5	0.3
Bongonet 180 µm	Bottom-0m	1000-0m	0.5	0.5
Bongonet 64 µm	Bottom-0m	1000-0m	0.5	0.3
MIK 1500 µm	Bottom-0m	1000-0m	0.3*	1.5

*If lowering to fast the net-bucket might flip into the net since the ring is much heavier than the bucket even when added weight to the bucket. The net bucket should be improved in order to attach heavier weights.

Table 7: Overview of gelatinous zooplankton samples.

Station	**Gear**	**Depth**	**Taxon**
P1	MIK net	170-0 m	*Aglanta digitale* *Beroe cucumis*
P3	MIK net	280-0 m	*Aglanta digitale* *Beroe cucumis* *Mertensia ovum* *Phytchogena lactea*
P4	MIK net	310-0 m	*Beroe cucumis* *Mertensia ovum* *Phytchogena lactea*
P5	MIK net	125-0 m	*Mertensia ovum* *Aglanta digitale* *Beroe spp.*
P6	MIK net	970-0 m	*Aglanta digitale* *Beroe* spp. *Mertensia ovum* Unknown Cydippid sp.
P7	MIK net Bongo net	1000-0 m	*Aglanta digitale* *Mertensia ovum* *Beroe* spp. Unknown

			Atolla spp.

3.2.3 RF3 T3-2.2&T3-4.4: Pelagic-benthic coupling: vertical flux

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3.2.3.1 Sediment trap deployment and sampling

To assess the vertical flux at the P-stations along the cruise transect, short-term sediment traps (KC-Denmark) were deployed between 11 and 27 h (Table 8) at P1, P2, P4, P5, P6 and P7 at 6 depths (30m, 40m, 60m, 90m, 120m and 200m). 4 traps were deployed at 30, 60 and 200m, and 2 traps were deployed at 40, 90 and 120m. Due to the shallow depth of P2 and P4 4 cylinders were deployed at 120m instead of 200m. Prior to the deployment, the cylinders were filled with pre-filtered deep water (below 200m, filtered through a Sartorius filtration system) from the NLEG station before the corresponding station to make sure that the water within the cylinders had a higher density than at the sampling depths. An anchor of 40kg was fixed to the bottom of the mooring to keep it upright in the water column. To keep the traps neutrally buoyant in the water, floatation was attached at 5m depth, and a surface buoy was kept at the top of the rig to ensure neutral buoyancy (Fig. 3.9). A flagged pole equipped with an AIS beacon was used to mark the location of the mooring and to relocate its position for recovery. A small buoy with a long rope was attached to the pole for the recovery of the mooring. At all stations except P1 a chain was added as a connection between the flagpole and the top part of the mooring. Additional buoys accounting for the weight of the chain were attached to the flagpole-end of the chain. At P5, P6 and P7 the mooring was attached to an ice floe, where the chain was secured with two metal poles that were hammered into the ice (Fig. 3.10). After recovery, the traps from each depth were pooled in one canister each, and processed within 10 hours afterwards.

At stations P4, P6 and P7, sediment traps were deployed by divers 1m below the sea ice. Two 2" holes were drilled with approximately 2m distance from each other, and approximately 20m upstream from the dive hole into the ice. A 3m long rope with a loop on the end was lowered and adjusted through these holes until the lower end of the loop was approximately 1m (between 80-110cm) below the ice. The traps were filled with pre-filtered seawater from the same deep water as for the rigged traps and secured with stoppers. The divers attached the traps (2 on each loop) with a carabiner and removed the stoppers. The two ropes were connected by floatation buoys in case the ice would break up, and the position of the ice floe was logged with an AIS. The deployment spot was visibly marked with a flag on a bamboo stick. After approximately 24 hours, the divers retrieved the traps by securing the traps with stoppers. All four traps were pooled in one canister and processed within 3 hours afterwards.

Table 8: Overview of sediment trap stations during AeN SSQ2 with deployment and recovery time, and the total time of deployment.

Station	Deployment time (UTC)	Recovery time (UTC)	Total time of deployment	Deployment conditions	Deployment depths (m)
P1	2021-04-30 15:46	2021-05-01 02:44	11h 58m	Open water	30m, 60m, 90m, 120m, 200m
P2	2021-05-02 02:51	2021-05-02 15:32	11h 41min	Under thin ice conditions	30m, 40m, 60m, 90m, 120m
P4	2021-05-04 21:33	2021-05-06 00:18	26h 45min	Under ice conditions, in a lead	30m, 40m, 60m, 90m, 120m, 200m
P4	2021-05-05 12:52	2021-05-06 11:25	23h 33min	Under the ice	1m
P5	2021-05-07 12:24	2021-05-08 14:15	25h 51 min	Attached to an ice floe	30m, 40m, 60m, 90m, 120m
P6	2021-05-09 18:30	2021-05-10 17:48	23h 18min	Attached to an ice floe	30m, 40m, 60m, 90m, 120m, 200m
P6	2021-05-10 09:12	2021-05-11 12:15	27h 3min	Under the ice	1m
P7	2021-05-13 19:30	2021-05-14 21:37	26h 7min	Attached to an ice floe	30m, 40m, 60m, 90m, 120m, 200m
P7	2021-05-13 13:29	2021-05-14 12:46	23h 17min	Under the ice	1m

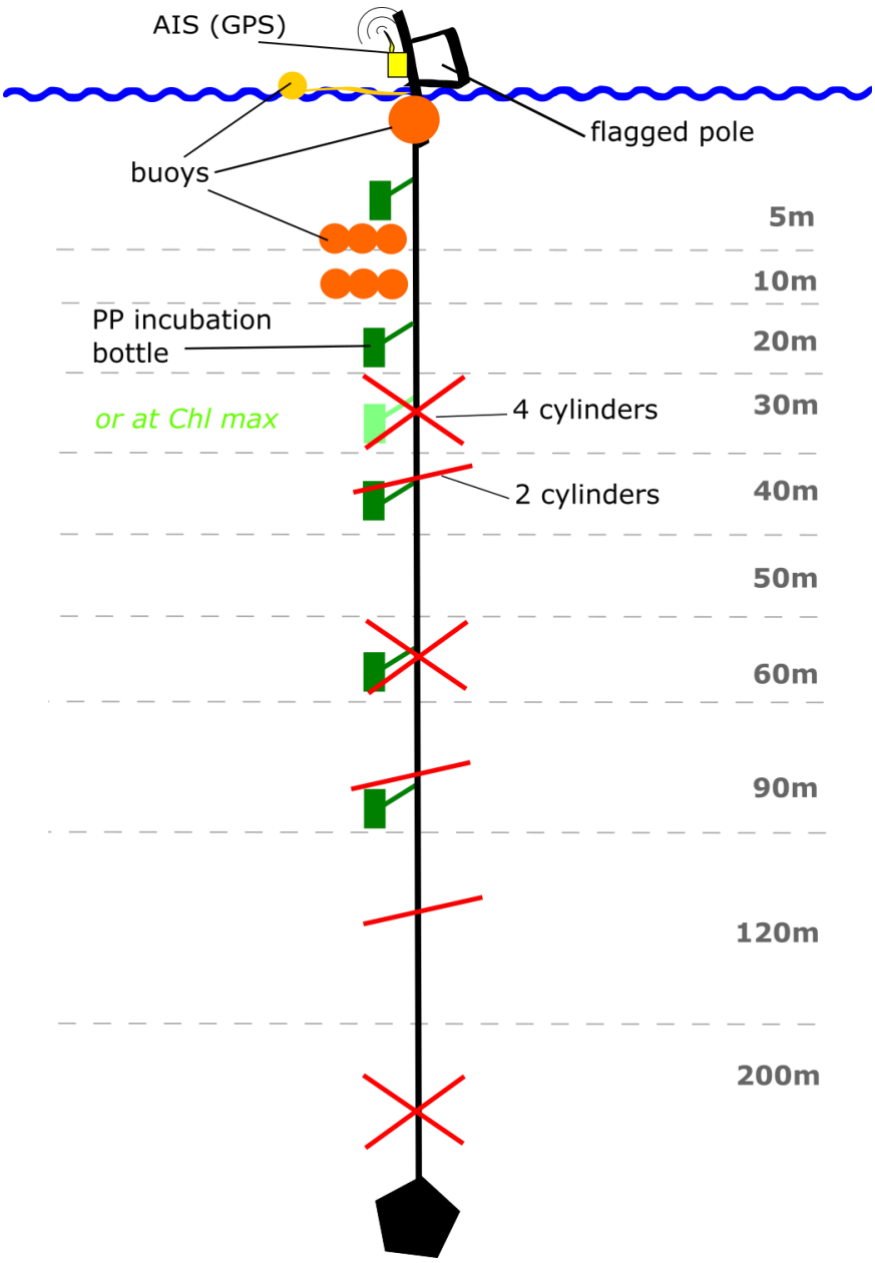

Figure 3.9: Scheme illustrating the structure of the mooring and the sampling depths of the sediment traps at open water conditions.

Figure 3.10: Deployed sediment trap under ice conditions (left) and on an ice floe (right) during SSQ3 in August 2019.

Sampling largely followed the Nansen Legacy sampling protocol version 8, chapter 8. Upon recovery of the sediment traps, the cylinder content of each depth was pooled and partitioned. From each depth, water was filtered for triplicate POC/PON analyses on pre-combusted GF/F filters and for size fractionated algal pigments (total Chl a (in triplicates on GF/F filters) and Chl a >10µm; on Polycarbonate filters) and water samples were taken for microscopic counts of fecal pellets and phytoplankton communities. Filters for algal pigments were immediately extracted in methanol at 4C and measured with a fluorometer on board ideally after 12-24 h. Fecal pellets were preserved in a hexamine-buffered 4% Formaldehyde solution and phytoplankton communities in GA-Lugol. At 30m, 60m and 200m and for the under-ice traps, additional triplicate samples were filtered for stable isotopes (pre-combusted GF/F) and stored at -80C. If volume was left, additional samples were taken for particulate biogenic silica (bSi; on 0,8µm polycarbonate filters), HPLC (GF/F) IP25 (GF/F), nutrients (40ml sterile-filtered over 0.22µm GFF filters into Falcon tubes), protist DNA and particle-associated bacterial DNA analyses (approx. 500ml was filtered through sterivex filters or through 10µm PC filters, respectively). DNA, IP25, HPLC and stable isotopes samples were stored at -80C. POC/PON, nutrients and bSi were stored at -20C. Field blanks for POC/PON analyses were taken at all stations except P5 by filtering MilliQ on combusted GF/F, stored at -20C. Field blanks for bSi were taken by filtering MilliQ on 0.8µm PC filters at P1 and P7. For additional control of the pre-filtered water that was used for the deployments, samples for POC/PON, nutrients and bSi were taken from the pre-filtered water and processed as described above, usually after the recovery of the sediment traps.

3.3 Chemistry

3.3.1 RF2 T2-1-1: Current variability and drivers of ocean acidification

Elizabeth Jones (onboard); Melissa Chierici (PI; not onboard), Agneta Fransson (PI; not onboard)

The focus of the work onboard was to investigate carbonate and nutrient chemistry for the study of ocean acidification and the carbon cycle in the surface water, full water column and sea ice environment (snow, ice, brine, under-ice water) in different regimes and across natural gradients. The water column and sea ice were sampled for carbonate chemistry (total alkalinity (AT), total inorganic carbon (DIC), inorganic nutrients and stable oxygen isotopes ($d^{18}O$) and analyses for the determination of dissolved oxygen were performed onboard.

Seawater was sampled from Niskin bottles mounted onto a 24 bottle CTD-Rosette from a total of 25 stations for post-cruise analyses of carbonate chemistry, nutrients and $d^{18}O$. Sampling and future analysis followed the protocol described in *Nansen Legacy Sampling Protocol version 7 and Dickson et al. (2007)*. The samples for carbonate chemistry were sampled first or directly after dissolved oxygen samples and stored in the cool and dark for post-cruise analyses at IMR in Tromsø. Samples for inorganic nutrients (nitrate+nitrite, nitrite, phosphate, silicic acid) were preserved with chloroform and stored at 4°C in the dark for post-cruise analyses at IMR in Bergen.

Dissolved oxygen was sampled from 8 CTD stations. On each station replicate sampling was performed at least one depth to ensure that the analytical performance was acceptable. The data from the Winkler titration showed that the oxygen sensor on the CTD had an offset of on average 0.4-0.9 ml/L between P1 and P7. The CTD profiles indicate that the performance was overall good and a largely consistent offset, which can be corrected for in post-processing.

Six sea ice stations were sampled (P2, P3, P4, P5, P6, P7) for ice cores, snow, brine and under-ice water. A total of 11 ice cores with a length from 16 cm to 126 cm of first year ice were sampled. At all stations snow depth, ice thickness and freeboard were measured alongside temperatures for each ice core. Under-ice water was sampled by divers into plastic Nalgene bottles at 0.5 m below the ice surface. Brine was sampled using (i) a sack hole drilled 10-20 cm into the ice with an ice corer and (ii) using plastic syringes from brinicles on the underside of the sea ice by divers. Ice cores were sampled and processed as described in *Nansen Legacy Sampling Protocol version 8*. Ice cores were sliced into 10-cm sections from the top (snow-air interface) to the base (ice-seawater interface) and were melted in airtight bags (or cups for alkalinity and salinity measurements) at laboratory temperature and subsampled for carbonate chemistry, nutrients and $d^{18}O$. Samples were preserved and stored for post-cruise analysis as described above. Total samples for carbonate chemistry, inorganic nutrients and stable oxygen isotopes in

seawater and sea ice were 770. Table 1 summarizes the seawater sampling from the CTD-Rosette.

The underway instrumentation for autonomous high-frequency surface water measurements of partial pressure of CO2, pCO2 (General Oceanics), was running in ice-free water from ship's seawater intake at 4 m depth. The instrument was running after the seawater supply had been switched on after leaving coastal waters in the afternoon of 28 April. Raw data are calibrated against a series of reference gases (comprising different CO2 concentrations) and will be quality controlled in post-cruise processing. In addition, a series of seawater samples to be analysed for AT/DIC/pH were collected from the seawater line in contrasting regimes (e.g., Atlantic Water, bloom waters) to perform an internal consistency check on the data using the CO2 chemical speciation program CO2Sys.

Table 9: Seawater samples from the CTD-Niskin Rosette.

Station Name	CTD #	# AT/DIC/pH	# Nutrients	# $d^{18}O$	# $DO_{Winkler}$
Pre-P1	161				3
P1	163	11	11	11	12
NLEG2	168	10	10	10	
NLEG3	169	8	8	8	
P2	171	9	9	9	10
NLEG5	173	9	9	9	
NLEG6	174	9	9	9	
P3	175	11	11	11	12
NLEG8	177	9	9	9	
NLEG9	178	9	9	9	
NLEG10	179	10	10	10	
P4	182	11	11	11	7
NLEG12	185	8	8	8	
P5	187	9	9	9	10
NLEG14	189	9	9	9	
NLEG15	190	10	10	10	

NLEG19	194	12	12	12	
P6	199	13	13	13	8
NLEG23	203	14	14	14	
P7	206	17	17	17	10
P7 ice	211		4	4	
NLEGA	212		4	4	
NLEGB	213		4	4	
NLEGC	214		4	4	
NLEGD	215		4	4	

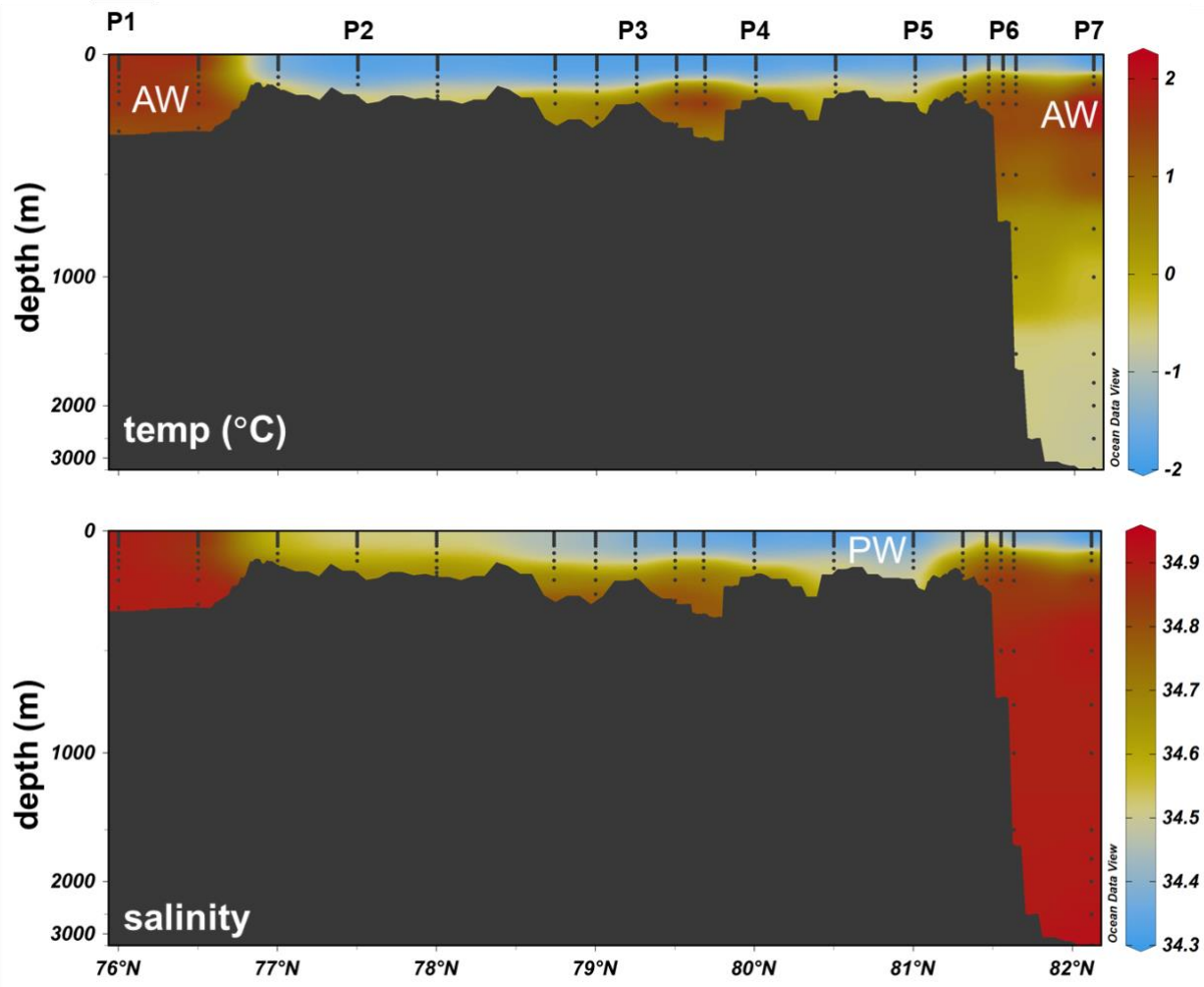

Figure 3.11: Preliminary CTD data from the water column Temperature (upper panel) and salinity (lower panel) in the full water column from south (P1) to north (P7), including numerous NLEG CTD stations along the transect. Atlantic Water (AW) and Polar Water (PW) are indicated for reference.

3.3.2 RF2 T2-1.2 Ocean acidification effects on the mobility of particulate and dissolved organic carbon (POC, DOC), essential trace elements (micronutrients) and heavy metals

Stephen Kohler & Matthew James Samuel Adams (NTNU)

Objective

The purpose of this task is to understand the impact of ocean acidification on the biogeochemistry (cycling and mobility) of dissolved organic carbon (DOC) and trace elements in the water column of the Northern Barents Sea. To best explore this topic, a complete survey of trace elements and heavy metals needs to be sampled along the entire transect and at various depths under clean sampling and handling conditions. In addition, the characterization of dissolved organic matter (DOM, DOC), at each station at select

depths will aid in understanding the different forms and distributions of DOM and how they may interact with trace elements. As the solubility of trace metals, both essential and toxic, are dependent on its interaction with DOM, the distribution and type of both trace metals and DOM was surveyed.

Trace elements (micronutrients)

Both total (n= 56) and dissolved (n= 56) trace elements, were successfully sampled at all process stations (P1-P7) at eight depths up to 15 m above the seabed or up to 500m with GO FLO bottles with clean sampling and handling techniques. Replicate samples were collected at certain stations. Two ice cores sampled and sectioned at P4 and P7 for total trace elements.

Additionally, samples to determine phytoplankton iron quota were collected from the chl a max depth at all stations. Briefly, samples from the chl a max depth were filtered sequentially on filters with 3 pore sizes under clean sampling techniques. Filters were frozen and collected to determine the iron quota.

Heavy metals (Hg)

Separately, samples for both total mercury (n=56) and methylmercury (n=56) were also collected at all process stations (P1-P7) at eight sampling depths up to 500m with GO FLO bottles using clean sampling and handling techniques. At stations P6 and P7, samples for total mercury and methylmercury were also collected from the deeper depths (>500m) from the CTD rosette with bottles to complete the profile. Replicate samples were collected at P3, P4, P5, P6 and P7. To compare the clean sampling technique to the CTD, samples were collected from the CTD at P7 at the same depth as one of the GO FLO depths. We hope to share mercury data with RF2, T2-2, and RF3, T3-4.1.

At P5, the 10m depth was selected for a stable isotope mercury methylation experiment. Briefly, stable isotopes of inorganic ^{199}Hg and $Me^{201}Hg$ were spiked to unfiltered seawater incubations in triplicate and preserved at two time periods over the course of 24 hours. Samples were collected for Hg isotopes and characterization of dissolved organic matter. This experiment is planned to be was performed already in March 2021, on Q1. This data will aid in understanding both methylation and demethylation rates throughout the water column in the Arctic basin in the presence of seasonal DOM regimes.

Three ice cores were sampled at stations P4, P6, and P7 and sectioned for both total Hg and MeHg determination. In addition, under ice water was collected from all sea ice stations.

Dissolved organic matter (DOM) characterization, and Dissolved organic carbon (DOC)

Samples were collected for 6 depths *(10m, 20m, 30m, 60m, 90m and bottom depth)* . Process stations (P1, P4, P6, P7) were sampled and collected from CTD bottles. All samples were subsequently collected, filtered, and extracted for DOM to be analyzed post-cruise. In addition, samples including replicates were collected for DOC analysis at 6 depths at each aforementioned station to complement DOM characterization analysis. DOC analysis will be performed using high temperature combustion TOC instrument.

Three ice cores were sampled at stations P4, P6, and P7 and sectioned from 0-20cm (bottom) and melted in the dark. Water was filtered for collection for DOC and extracted for DOM. Under ice water was also collected at stations P4, P6 and P7 and filtered for DOC and extracted for DOM.

Sediment sampling

At stations P1, P2, P4, P6, P7, samples of surface sediments were collected by the benthos group for trace element analysis by sequential sediment extraction and for total mercury analysis.

3.3.3 RF2 T2-1-4 Human impacts–Ocean acidification effects on planktonic calcifiers and biological pump efficiency

Griselda Anglada-Ortiz (UiT) (onboard), Supervisor: Tine L. Rasmussen (UiT) (not onboard)

The abundance of the main planktic marine calcifiers (foraminifera, pteropods and coccolithophores) and their contribution to the carbon pump will be studied from 64 µm multinet samples (foraminifera and pteropods) and niskin bottles (coccolithophores) regarding the water chemistry from the sampling zone.

A total number of **314** samples have been retrieved on the P stations along the transect to study these marine calcifiers following the protocol from the Nansen Legacy v8.

On one hand, **33** samples have been collected using the 64 µm multinet on all P stations at the standard depths: 0–20 m, 20–50 m, 50–100 m, 100–200 m and 200–300 m (the shelf stations shallower than 300 m the same standard ranges were followed). All samples have been washed through a cascade of sieves obtaining four size fractions (>500 µm, 250–500 µm, 100–250 µm, 63–100 µm) from each sample (total number of multinet samples= **132)**. Once on deck, **137** pteropod and foraminiferal specimens have been individually picked from the upper 100 m and (individually) frozen at - 80° C for protein extraction analysis. The rest of the samples have been analysed for pteropods and foraminifera (abundance and species distribution), stored on plastic bags, and preserved at - 20° C.

On the other hand, **45** samples coming from the P stations (1, 2, 4, 5, 6 and 7) and different depths (90 m, 60 m, 50 m, 20 m and 10 m) have been collected from the niskin bottles. A total volume of 8 L were sampled and filtered through a 0.45 µm Acetate cellulose membrane (volume=3 L; depths 10, 20, 50, 60 and 90 m) and 0.4 µm Polycarbonate membrane (volume=5 L; depths 10, 20 and 50 m). Once the samples have been filtered, the filters have been rinsed with distilled water buffered with ammonia (5 ‰) and oven dried at 60° C.

Table 10: Overview of the samples collected during Q2 2021.

	Coccolithophores (niskin)	Foraminifera and pteropods (multinet)
P1	10, 20, 50, 60 and 90 m	0-20, 20-50, 50-100, 100-200, 200-300
P2	10, 20, 50, 60 and 90 m	0-20, 20-50, 50-100, 100-170
P3		0-20, 20-50, 50-100, 100-200, 200-300
P4	10, 20, 50, 60 and 90 m	0-20, 20-50, 50-100, 100-200, 200-300
P5	10, 20, 50, 60 and 90 m	0-20, 20-50, 50-100, 100-125
P6	10, 20, 50, 60 and 90 m	0-20, 20-50, 50-100, 100-200, 200-300
P7	10, 20, 50, 60 and 90 m	0-20, 20-50, 50-100, 100-200, 200-300

One sea ice core was collected on P5, which was sliced at 3, 10, 20 and 30 cm, melted and filter into an acetate cellulose membrane in order to study the presence of foraminifera and coccolithophores in the ice.

3.4 Zooplankton

3.4.1 RF3 T3-3.1: Macrozooplankton abundance, biomass, and species composition

Elisabeth Halvorsen (UiT)

3.4.1.1 Objective

The aim of the sampling is to provide information on seasonal and regional variation in abundance, biomass, and genetic composition of the microzooplankton community along a North-South gradient in the Barents Sea.

3.4.1.2 Description of sampling

Biomass was taken with vertical hauls of the MIK net (1500 µm) from the bottom to the surface at all process stations, with exception of the deepest stations, P6 and P7, where the net was hauled from 1000m to the surface, due to time restrictions. Rare taxa and gelatinous zooplankton were isolated from the sample and two subsamples were weighted and taken for (1) for metabarcoding stored in ethanol at -20 degrees C, and (2) for later taxonomic identification of species, stored at room temperature in 4% buffered formaldehyde. Genetic identification of the picked out gelatinous zooplankton will be analyzed separately (see gelatinous zooplankton sample log). Macrozooplankton trawl and acoustics were not undertaken on this cruise.

Table 11: Station overview including gear used (Net), depth sampled and targeted taxa.

Station	Net	Depth	Taxa
P1	MIK net 1500 µm	316-0m	*Calanus* spp., *Sagitta* spp.,
P2	MIK net 1500 µm	169-0m	*Very little biomass*
P3	MIK net 1500 µm	285-0m	*Calanus spp., Aglantha digitale*, *Phytchogena lactea*, *Beroe cucumis*, *Mertensia ovum*
P4	MIK net 1500 µm	327-0m	*Clione limacine*, *Calanus* spp., *Mertensia ovum*, *Phytchogena lacta, Thyssanoessa* spp., *Themisto* spp.
P5	MIK net 1500 µm	166-0m	*Calanus spp. Cliona limacine, Beroe spp., Mertensia ovum*
P6	MIK net 1500 µm	1000-0m	*Calanus* spp., *Paraeuchaeta* spp., *Aglantha digitale*, *Sagitta* spp., *Thyssanoessa* spp., *Themisto* spp., Shrimps
P7	MIK net 1500 µm	1000-0m	*Calanus* spp., *Pareuchaeta* spp., *Sagitta spp., Themisto* spp., Amphipoda, Shrimps

3.4.2 RF3 T3-1.3: Stable isotopes, fatty acids & HBIs of POM, zooplankton & fish

Doreen Kohlbach, Philipp Assmy, Haakon Hop & Amalia Keck (NPI)

3.4.2.1 Purpose

Samples of the trophic baseline (phytoplankton and ice algae) and the main zooplankton taxa were collected for the analysis of fatty acids (FA), fatty acid-specific stable isotopes (SI) and highly branched isoprenoids (HBIs) to study coupling/de-coupling of sympagic and pelagic primary and secondary producers.

3.4.2.2 Description of work

Trophic baseline: PPOM (pelagic particulate organic matter) and IPOM (ice-associated POM)

30 L of seawater from 20 m depth (when there was no clear chlorophyll *a* maximum) or the chlorophyll *a* maximum was collected with Niskin bottles attached to a CTD at all process stations (P1-P7). Seawater was filtered through pre-combusted 47 mm GF/F filters to obtain pelagic particulate organic matter (PPOM). We filtered between 2.5 and 3L in three replicates for all parameters (FA, SI, HBI) in order to get enough material. Blanks with MilliQ were obtained for each parameter at each station. Ice cores (6 cores per station, bottom 10 cm) were taken at three stations (P4_ice, P6_ice, P7_ice). Ice cores were melted at cold temperatures and between 200 and 650 mL of melted cores were filtered through 47 mm pre-combusted GF/F filters to obtain ice-associated particulate organic matter (IPOM) in three replicates for all parameters (FA, SI, HBI). At stations P4_ice, P6_ice and P7_ice, ice algae were additionally sampled by the divers with a suction pump (20 µm) and between 50 and 100 mL were filtered through pre-combusted 47 mm GF/F filters. Blanks with MilliQ were obtained for each parameter at each station. Filters were frozen at -80°C.

3.4.2.3 Zooplankton

Samples of meso- and macrozooplankton were collected at all seven process stations with MIK (1500 µm) and WP3 (1000 µm) nets (Table 12). This work was done in collaboration with the Ecotoxicology group (Julia Giebichenstein and Robynne Nowicki). Samples were taken from the bottom to the surface at each station except at the deep station (P7) were samples were taken from midwater and up due to time restrictions. Additionally, zooplankton was collected with a macrozooplankton trawl during transit from station P4 to P5. Samples of ice-associated amphipods (*Apherusa glacialis, Eusirus* spp.*, Onisinus* spp., *n* = 70) were collected by the divers with a suction pump (200 µm) at stations P6_ice and P7_ice. All samples were frozen at -80°C.

3.4.2.4 Fish

Polar cod was collected at station P1 and during transit from station P2 to P3 with a pelagic trawl (samples are listed in the Ecotox section). Additionally, polar cod was collected by the divers with a spear at station P6_ice (*n* = 4).

Table 12: List of samples collected with during Q2 for trophic marker analysis

Sample type/taxonomic group	Taxa/species	Collected at station	# samples

Trophic baseline	Pelagic particulate organic matter (PPOM)	P1, P2, P3, P4, P5, P6, P7	63
	Ice-associated particulate organic matter (IPOM)	P4_ice, P6_ice, P7_ice	57
Copepods	*Calanus glacialis*	P1, P2, P3, P5, P7	33
	Calanus hyperboreus	P1, P3, P4, P5, P6, P7	83
	Calanus finmarchicus	P1	2
	Paraeuchaeta spp.	P1, P3, P4, P6, P7	34
Krill	*Thysanoessa spp.*	P1, P2, P3, P4, P5, P6, P7	65
	Meganyctiphanes norvegica	P1, P6, P7	8
Amphipods	*Themisto abyssorum*	P1, P4, P6, P7	23
	Themisto libellula	P2, P4-P5, P6	7
Pteropods	*Clione limacina*	P2, P3, P4-P5, P5, P6, P7	39
Chaetognaths	*Sagitta spp.*	P1, P3, P4, P5, P6, P7	69
	Sagitta maxima	P6, P7	14
	Eukrohnia hamata	P6, P7	7
Ctenophores	*Mertensia ovum*	P2, P3, P4, P5, P6, P7	26
	Beroë cucumis	P1, P2, P3, P4, P5, P6	16
	Aglantha digitale	P1	3

3.4.3 RF2 T2-2.5: "Critical seasonal windows of responses to multiple stressors on key organisms in a pelagic food chain"

Robynne Nowicki (UNIS/UiO, onboard), Supervisors: Øystein Varpe (UiB), Geir Wing Gabrielsen (NPI), Katrine Borgå (UiO), Janne Søreide

3.4.3.1 Purpose

The samples taken on this cruise will be used in T2-2.5 "Critical seasonal windows of responses to multiple stressors on key organisms in a pelagic food chain". Macrozooplankton and fish samples will be taken on all four seasonal cruises (Q1-4) for bioenergetics, protein, lipid and pollutant remobilization analysis. The samples taken will be used to assess seasonal fluctuations in energy content of key organisms in the pelagic food web of the Barents Sea. This data will be used to expose annual critical windows in which organisms may be of weakened body condition and predators may have a low-quality food supply. Thus, these organisms may be more susceptible to stressors such as persistent organic pollutants and climate change parameters, during this critical period. As well as this, polar cod brains were collected (to be used in conjunction with brains collected from kittiwakes from Svalbard in future) for organ specific analysis of seasonal pollutant remobilization. Samples were taken at each process station (excluding P3), allowing for additional comparison of southern (Atlantic) and northern (Arctic) species, as well as regional differences in individuals of the same species.

3.4.3.2 Sampling approach

Macrozooplankton: Macrozooplankton were sampled using MIK-net 1500um V- hauls and vertical hauls depending on ice conditions. A Macrozooplankton trawl was also used between P5 and P6. Multiple MIK nets were taken at each station to provide substantial biomass. The bulk samples were sorted into major zooplankton groups, with this work focusing on krill and amphipods, with 2 species selected for each, with Clione limacina also opportunistically sampled (see overview table). Individuals were selected and measured, with an aim to collect a range of size classes, in order to assess the relationship between life history stage and energy content. However, due to the low abundance of larger macrozooplankton in the water this time of year, Calanus copepods were also targeted, using WP3 1000um nets in addition to MIK nets. For each sample, organisms were wrapped in aluminium foil, or placed in cryovials (copepods) and placed in a labelled Ziploc bag and frozen at -20°C. Organisms of the same species and size class were pooled together in order to achieve a sample that weighed 2-3g. Samples were taken opportunistically, with not all species being collected from each station.

Fish: Fish were collected using campelen trawl at station P1 and P3. Capelin (Mallotus villosus) and polar cod (Boreogadus saida) were the target species collected (see overview table). The fish were taken whole from the trawl, weighed and measured for total length. Individuals were then wrapped in aluminium foil and frozen at -20°C. Polar cod that were dissected for other simultaneous sampling onboard had their brains removed for remobilization studies, with weight and total length of the individual recorded.

Table 13: Zooplankton overview table: Number of samples taken per species per station

Station	*T. inermis*	*M. norvegica*	*T. libellula*	*T. abyssorum*	*C. limacina*	*C. glacialis*	*C. hyperboreus*
P1	5	2	-	-	-	-	-
P2	-	-	-	-	2	1	-
P3	1	2	-	-	2	2	2
P4	-	-	-	-	-	1	4
P5	2	-	1	-	-	1	3
P6	1	3	2	4	-	-	8
P7	-	1	-	1	-	-	9

Table 14: Fish overview table: Number of samples taken per species per station

Station	**Capelin**	**Polar cod**
P1	22	22
P3	1	18

3.4.4 RF3 T3-4.2: Copepod diet studies

Snorre Flo (UNIS/UiT)

Sampling went as planned. Samples were taken both for the currently running "copepod diet project" starring the small copepods *Oithona similis*, *Microsetella norvegica* and *Microcalanus* spp., and for a future project on the trophic interactions of meiofauna.

3.4.4.1 Purpose of sampling

Samples were taken for my PhD-project on the trophic interactions of small invertebrates (<1 mm adult length) in the water column (small copepods) and in benthic sediment (meiofauna; e.g. nematodes). All samples are fixed on ethanol, kept cool (-20°C) and brought back to the lab at UNIS for dietary metabarcoding analysis. At UNIS, a number of each study species are picked, DNA is extracted from whole-body individuals, and further preparations are made for deep sequencing of the 18S small subunit (SSU) rRNA gene. Deep sequencing raw data is further processed in a bioinformatics pipeline to remove

unwanted sequences (e.g. the sequence of the study-species itself, and symbionts), and with the help of an experimental control group (starved copepods).

Fig. 3.12: Two of the copepods of interest: Microsetella norvegica (left) and Microcalanus spp. (right).

3.4.4.2 Corrections to the Nansen Legacy sampling protocol (v8)

Mesozooplankton sampling: No starvation incubation was started for small copepods from P1. This was due to extensive clogging and a high abundance of diatoms including *Thalassiosira* spp., *Chaetoceros* spp. and *Fragilariopsis* spp. species of different sizes. It was initially attempted to isolate small copepods (200 < 1000 µm) as per usual with sieving, but it was impossible to get the solution sufficiently devoid of potential food items. The remaining solution was kept as a backup P1 sample.

Sediment sampling was conducted as before, with the exception that two replicate sediment samples were taken with a syringe, and not a spoon. This was arranged to increase the sample material of potentially abiotic meiofauna (>10 cm subsurface).

3.4.4.3 Sample overview

Table 15: List of samples. All samples were fixed with ice-cold ethanol (96%, -20°C) and put immediately in the freezer (-20°C). Sediment was sampled three times from separate box-cores at P1, P2, P4, P6 and P7.

Table 15: Sample overview

Station	Meiofauna (sediment)	Mesozooplankton	Mesozooplankton starved
P1	3	2	-

P2	3	1	1
P3	-	1	1
P4	3	1	1
P5	-	1	1
P6	3	1	1
P7	3	1	1

3.4.5 RF2 T2-2.1: Effects of changes in species composition and distribution on contaminant in food web accumulation

Julia Giebichenstein (UiO, onboard), Helene S. Thorstensen (UiO, onboard), PI: Katrine Borgå (UiO)

3.4.5.1 Purpose

As changes in temperature and sea ice distribution and thickness are expected in the Barents Sea, the energy transfer processes in the food web are expected to change. The present study aims at identifying and comparing bioaccumulation and biomagnification processes of legacy and emerging contaminants (e.g. persistent organic pollutants and mercury) related to energy use and availability between an Atlantic-influenced and an Arctic marine pelagic food web in the Barents Sea throughout the year. Zooplankton and fish samples will be collected during the process study cruises. From these, chemicals representing lipid soluble, and protein associated contaminants will be analyzed, in addition to dietary descriptors to trace energy source (stable isotopes and lipid analyses). Model predictions of climate change effect on food web accumulation of contaminants include reduced accumulation due to predicted reduction in lipid storage. Bioaccumulation changes due to altered dietary composition is predicted to have less influence than the predicted lower lipid content. These predictions will be tested in the present task.

3.4.5.2 Sampling approach

During this cruise we have collected water, zooplankton and fish samples for legacy contaminants, mercury, stable isotope, fatty acid and genetic analyses. Doreen Kohlbach (NPI) will analyze the fatty acid samples and the stable isotope and mercury samples will be analyzed at UiO, contaminant samples will be analyzed at NILU in Tromsø. Genetic analyses will be done by Sissel Jentoft at UiO. We hope to share mercury data with T2-1.2.

Water samples for legacy persistent organic pollutant (POP) analyses were collected with an in-situ filtration pump (see Figure 3.13) at the process stations P7, P6, and P4.

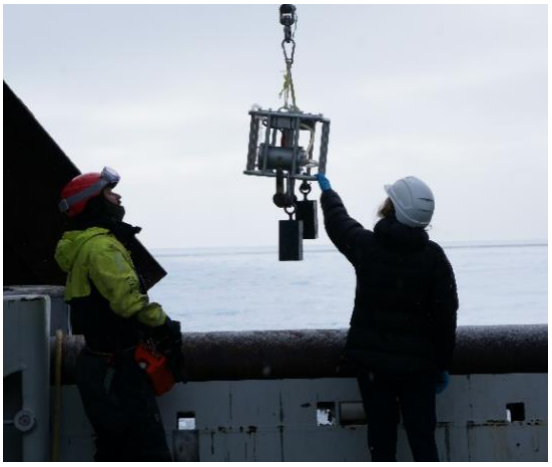

Figure 3.13: Deployment of the filtration pump

Meso- and macrozooplankton samples of key food web species were collected at each process station. Mesozooplankton (primarily Copepod stages CV and females) were sampled with either WP3 or Bongo Nets. Copepods clearly dominated the sampling during this cruise, as abundance of Macrozooplankton was extremely low. Macrozooplankton (mainly euphasiids, amphipods and juvenile fishes) samples were collected from the MIK net. All zooplankton samples were sorted and grouped by family and by species, if possible. Samples for contaminants were handled as little as possible and frozen as quickly as possible to avoid cross-contamination. We sampled for POPs, mercury, stable isotope and fatty acid analyses.

Figure 3.14: Themisto libellula, Photo credit: Christine Gawinski.

The macrozooplankton trawl was deployed between P4 and P5, but due to slush ice in the net, most animals were killed and could not be used for our analyses.

Fish tissue and whole fish were sampled via bottom trawl for POPs, mercury, stable isotope fatty acid analyses at P1 and between P2 and P3 on our way back to Tromsø. Fish stomachs were frozen for diet and potential microplastic analyses and otoliths for age determination were dissected. The target species relevant to the pelagic Barents Sea food web included Polar cod (*Boreogadus saida*), Atlantic cod (*Gadus morhua*) and Capelin (*Mallotus villosus*) and were below 25 cm in total length (see Table 16).

Table 16: Overview of the number of dissected fishes at the process stations.

Process station	**P1**	**P2/P3**
Atlantic cod (*Gadus morhua*)	0	0
Polar cod (*Boreogadus saida*)	10	5
Capelin (*Mallotus villosus*)	10	5
Leptoclinus macullatus		5

3.4.6 RF3: Zooplankton respiration

Konrad Karlsson (onboard) & Janne Søreide (UNIS)

Respiration is an estimate of biological activity. This experiment is aimed to measure respiration and the main factors that affect respiration on an individual level.

Copepods were sampled from different stations along the cruise transect, P2, P4, and P6. Measurements were taken on individuals of different species, *Calanus finmarchicus*, *C. glacialis*, *C. hyperboreus*, *Metridia longa*, *Paraeuchaeta* spp., and different life stages and sexes, C5, C6, females and males. A photo was taken of every individual that respiration was measured on. From the photos morphological measurements of prosome length, prosome area, and lipid sac area, will be taken later on. The majority of the individuals were kept for later measurements of dry weight. In addition, individuals were incubated to measure their grazing rates and egg production, by putting one individual in a flask with seawater over 48 hours.

The data analysis will take place during the summer of 2021. The aim of the analysis is to see which covariate that best explains individual variation in respiration rates of dry weight, grazing rate, and egg production.

3.4.7 RF3: Two-point Dilution and grazing experiments

Maja Hatlebakk & Nicole Aberle-Malzahn (NTNU)

3.4.7.1 Purpose

The outcome of the experiments is relevant for T3-3.1 & T3-4.2. The purpose of the experiments is to investigate nutritional variations and selective feeding of Arctic and

sub-Arctic plankton consumers along latitudinal gradients in the Barents Sea in different seasons.
The focus is the primary producer-consumer link of lower trophic plankton communities in the Barents Sea and adjacent Arctic Ocean. By means of two-point dilution and grazing experiments, effects of food quantity and quality on growth and nutritional composition of consumers will be investigated as well as selective grazing and food web structures using natural plankton communities.
As main grazers in the microbial loop, microzooplankton (20-200 µm) represent an important intermediate link between primary producers and secondary consumers such as mesozooplankton.
Mesozooplankton (0.2 mm-2 cm) in turn represents an important food source for higher trophic levels such as early life stages of fish and other planktivores.

3.4.7.2 Sampling approach

Two-point dilution and grazing experiments were run at stations P1, P4 and P7.
Water for the experiment was collected from 20 m depth and Bongonets (64 µm) were hauled from 70-0 m. Samples were collected for phytoplankton and microzooplankton taxonomy and abundance, flow cytometry, nutrients, ammonium, HPLC, Chl A, POC/PON and POP before the start of the experiment.

3.4.7.3 Experimental set up

The experiments were set up with five treatments in triplicates: 20 % dilution, 100 % <180 µm, 100 % <180 µm with 50 Oithona spp., 100 % <180 µm with 5 Calanus spp., and 100 % <180 µm with added nutrients (1mL L-1). The treatments were prepared in 2.5 L incubation bottles and incubated for 2-3 days at 1-2 degrees and 24 h light regime. At the end of the experiments the same parameters that were collected at the start of the experiment were collected from each bottle.

3.4.8 RF3 - T3-2.2: Secondary production

Christine Gawinski & Camilla Svensen (UiT)

The goal of this task is to characterize how current environmental settings drive the seasonality of copepod production. To meet this goal mesozooplankton productivity was determined experimentally for selected key-species through egg-production/egg-hatching incubations in different seasons, representing species with contrasting life-history traits and reproductive strategies in open and ice-covered waters. Assuming that female copepods allocate their ingested carbon into egg production rather than into growth, the specific egg production rate can be used as an estimate of the production of the population. The focus during the cruise in May 2021 was on Calanus hyperboreus, Calanus glacialis, Calanus finmarchicus, Paraeuchaeta sp., Microsetella norvegica,

Pseudocalanus sp. and Oithona similis. To assess how population dynamics vary across space, egg incubation experiments were set up at three stations, namely P1 (1.5 ˚C), representing Atlantic conditions, P4 (-1.5 ˚C), based on the shelf and P7 (-1.5 ˚C), representing Arctic conditions.

Table 17: List of samples collected during SSQ2

Egg incubation experiments				
Station	Temperature (˚C)	Species	Number of individuals	Comment
P1	1.5	*Oithona similis*	20	
P1	1.5	*Paraeuchaeta sp.*	30	30 loose egg sacks
P1	1.5	*Microsetella norvegica*	30	
P4	-1.5	*Calanus hyperboreus*	30	Respiration was measured afterwards by Konrad
P4	-1.5	*Paraeuchaeta sp.*	42	30 loose egg sacs, 12 females with eggs
P5	-1.5	*Pseudocalanus sp.*	20	Most had less eggs than normal
P5	-1.5	*Oithona similis*	30	
P7	0	*Calanus hyperboreus*	50	30 randomly picked females, 20 females with eggs in oviduct, respiration of these was measured afterwards
P7	0	*Calanus finmarchicus*	30	
Bongo net samples for female:egg ratio				
Station	Net size (µm)	Fixative	comment	
P1	64	Formaldehyde	1 net	
P2	64	Formaldehyde	1 net	

P3	64	Formaldehyde	1 net
P4	64	Formaldehyde	1 net
P5	64	Formaldehyde	1 net
P6	64	Formaldehyde	1/2 net
P7	64	Formaldehyde	1 net
Bongo net samples NLEG-extra transect			
NLEG-A	64	Formaldehyde	1 net
NLEG-A	180	Formaldehyde	1 net
NLEG-B	64	Formaldehyde	1 net (hit the floor)
NLEG-B	180	Formaldehyde	1 net (hit the floor)
NLEG-C	64	Formaldehyde	1 net
NLEG-C	180	Formaldehyde	1 net
NLEG-D	64	Formaldehyde	1 net
NLEG-D	180	Formaldehyde	1 net
NLEG-E	64	Formaldehyde	1 net
NLEG-E	180	Formaldehyde	1 net
Grazer exclusion experiment			
Station	Treatment	Number of replicates	Temperature
P1	20 Oithona	3	1.5
P1	3 Calanus	3	1.5
P4	20 Oithona	3	-1.5
P4	3 Calanus	3	-1.5
P6	20 Oithona	3	-1.5
P6	3 Calanus	3	-1.5
CHN samples			

Species	type	Number of individuals	Station	comment
Paraeuchaeta sp.	females	30	P1	Frozen individually in cryo tubes
Paraeuchaeta sp.	Egg sacs	70	P1, P4	Frozen individually in cryo tubes (from experiment)
Microsetella norvegica	females	300	P1	100 individuals filtered on pre-combusted GF/Fs
Microsetella norvegica	Females with eggs	100	P1	100 individuals filtered on pre-combusted GF/Fs
Oithona similis	females	300	P4	100 individuals filtered on pre-combusted GF/Fs
Calanus glacialis	females	30	P4	Frozen individually in cryo tubes
Calanus finmarchicus	females	30	P7	Frozen individually in cryo tubes
Calanus hyperboreus	females	30	P7	Frozen individually in cryo tubes
Calanus hyperboreus	eggs	8 x 30	P7	30 eggs frozen in cryo tubes
Calanus hyperboreus	Nauplii	2 x 30	P4	30 nauplii frozen in cryo tubes
Paraeuchaeta norvegica	Nauplii	4 x 20	P4	20 nauplii frozen in cryo tubes
Paraeuchaeta glacialis	Nauplii	4 x 20	P4	20 nauplii frozen in cryo tubes
FA, SI samples				
Species	station	Number of individuals	replicates	comment

Oithona similis	P1	50	3	FA
Oithona similis	P1	50	3	SI
Oithona similis	P4	50	3	FA
Oithona similis	P4	50	3	SI
Oithona similis	P7	50	3	FA
Oithona similis	P7	50	3	SI

Oithona similis, Paraeuchaeta glacialis and P. norvegica, Pseudocalanus sp., Microsetella norvegica, Calanus hyperboreus and C. glacialis reproduced. *Calanus finmarchicus* did not reproduce.

3.5 Marine Robotics

Tore Mo Bjørkelund & Jens Einar Bremnes (NTNU)

For the Nansen Legacy Q2 cruise, team marine robotics brought four robots: (1) an unmanned surface vehicle (USV), (2) an autonomous underwater vehicle (AUV), (3) a remotely operated vehicle (ROV) consisting of two connected Blueye vehicles, and (4) a single Blueye vehicle.

3.5.1 P1 – open water station

During P1, both the USV and the AUV were deployed. The objective of the USV operation was to collect measurements of optical radiance and irradiance for verification and ground truthing of remote sensing satellite data.

In order to obtain measurements with homogenous influence from the sun, a constant relative angle of 135 degrees between the spectrometer and the sun was maintained. In order to achieve this, a table with the sun's azimuth was used for updating the heading of the ship every 30 minutes. Occasionally, the USV had to travel back closer to our position (thereby violating the 135 degrees relative degree requirement) in order to stay within communication range, this should be visible in the navigation data.

The main objective of the AUV operation was similar: collect spectrometric measurements (radiance and irradiance) under water at different depths. Additionally, the AUV was fitted with a CTD and an Eco Puck for measuring salinity, temperature and Chlorophyll A levels.

3.5.2 P4, P5, P6 and P7 – ice stations

The ROV was deployed at four ice stations: P4, P5, P6 and P7. The main objective of the ROV operations was to gather underwater hyperspectral images (UHI) of ice algae, as well as irradiance measurements. This data will be used for studying the optical properties of ice algae, and how they differ at different latitudes, ice morphologies and light conditions, as well as creating photomosaics. Moreover, the spectrometric measurements will be used for measuring the ice transmittance and water diffuse attenuation coefficients at the different ice stations. A hole in the ice was cut for the ROV to be deployed from. Transects of 40 meters with 0.5-2 meters distance to the ice were performed. This was repeated for all the aforementioned ice stations.

The secondary objective of the ROV was to gather multibeam echosounder (MBES) measurements for estimating the morphology of the under-ice environment, particularly ice ridges. Transects with 10-20 meters distance to the ice were performed at P4, P6 and P7. The data was successfully collected, although some challenges with navigation and control of the ROV was experienced, mainly due to poor accuracy of magnetic compasses at high latitudes and strong ocean currents.

Lastly, the Blueye vehicle was deployed at the same ice stations (P4, P5, P6 and P7) for video recording of the under-ice environment.

3.5.3 Ice work

The optics ice work was achieved as part of the RF1 sea ice physics work and in collaboration with Natalie Summers and the Robotics team (NTNU). It has also benefited from the valuable help and experience of Maja Hatlebakk (NTNU) for the ice coring part. Plan was to achieve two distinct tasks: (i) measuring the IOPs of the top layer of the water column without potential disturbance from the ship, (ii) measuring ice optical properties.

3.5.3.1 Pelagic observations from the ice

Pelagic observations of the water IOPs have been performed from the ice at P4 (May 5th) and P6 (May 10th). The ROV hole was used both for the water sampling and deployment of the optics cast. First the optics cast was deployed thanks to an electric winch down to approx. 50m depth. The CTD was immersed into a bucket of sea water right after the recovering of the cast and all the gear carried within 5 minutes to a warm place on the ship. This prevented any deterioration of the system due to the negative temperatures in the air. Water samples for particulate absorption and CDOM/FDOM were taken at 1, 2, 5 and 10m depth less than one hour after the optics cast.

3.5.3.2 Measurement of under ice downwelling irradiance and ice transmittance

Two Trios Ramses scalar irradiance sensors (ACC-VIS s/n 501C and 5029) were used for measuring above and below ice downwelling irradiances. These measurements were done at stations P4, P5, P6 and P7. One sensor was placed on a tripod for measuring the above ice downwelling irradiances. The second one was mounted on the double blue eye ROV by the robotics team of NTNU.

For the below ice sensor, different configurations were achieved in collaboration with the Robotics team:

(i) Transects along the Underwater Hyperspectral Imager (UHI) survey site.
(ii) Stationary measurements right below ice before/after snow removal
(iii) Stationary measurements at different depths for assessing the optical properties of the water column

This data will be used during the processing of the UHI data combining physical and biological mapping of the ice and its underside.

3.5.3.3 Measurement of ice sections IOPs

During the optics ice work at station P4 (May 5th), sectioned ice cores were taken for CDOM/FDOM and particulate absorption. The ice thickness ranged between 15-16cm. Bottom-5, bottom-10, bottom-20 sections were sampled.

3.6 Scientific diving

PI: Haakon Hop (NPI)

Divers: Haakon Hop, Amalia Keck Al-Habahbeh, Peter Leopold & Mikko Vihtakari (NPI)

Dive samples were collected on stations P4-Ice (2 days), P6-Ice (2 days) and P7-Ice (3 days) (Figure 2.1). In addition, P5-Ice was attempted but interrupted by polar bear visits. Only one sample of brine water was collected on that station. We collected under ice algae (60 ml syringes, 3.5 L slurp guns, suction pump with 20 µm net), water (60 ml syringes, 500 ml Nalgene bottles, 3.5 L slurp guns), brine water (60 ml syringes), mesozooplankton (200 µm swim nets, 25x25 cm opening, 80 m swim distance at 0, 1, and 5 m under sea ice), ice macrofauna (suction pumps with 200 µm mesh), polar cod (a spear) for the scientists on board (Table: sample log). In addition, the environment was documented using video and still cameras. We also deployed algal incubations and sediment traps for one day at the three stations. In total, 30 dives were conducted.

Figure 3.15: The dive team during Nansen Legacy Q2/21 cruise (left to right: Haakon Hop, Peter Leopold, Mikko Vihtakari & Amalia Keck Al-Habahbeh (NPI).

3.7 Benthos work

Arunima Sen (NORD), Eric Jorda Molina (NORD), Thaise Ricardo de Freitas (UiO), Silvia Hess (UiO)

During Q2, our team contributed primarily to the Nansen Legacy RF3 tasks T3-1 and T3-4, specifically subtasks T3-1-1, T3-1-2, T3-4-3 and T3-4-4. The gear used to collect samples included a demersal Campelen trawl and a box corer (50 x 50 cm).

3.7.1 Aims

The aims of the group were to:

1. ***T3-1-1: Characterize and quantify biota in the seasonal ice zone*** of the northern Barents Sea and adjacent Arctic Basin by sampling sediment communities for biodiversity and abundance/biomass assessments; specifically, microbes (PI Lise Øverås, UiB), benthic foraminifera (PIs Elisabeth Alve, and Silvia Hess UiO, with PhD student Thaise Freitas), multicellular meiofauna (PI Bodil Bluhm) and macro-infauna (PIs Paul Renaud, APN and Henning Reiss via PhD student Eric Jorda Molina, Nord University).

2. ***T3-1-1: Characterize biota in the seasonal ice zone*** by collecting voucher material of benthic macro- and megafauna to be archived at the UiT Museum for a legacy of physical material of the project (PIs Bodil Bluhm, Andreas Altenburger UiT)
3. ***T3-1-2: Relate environmental conditions to biological communities*** by sampling for sediment properties (grain size), indicators of food availability (total organic carbon and nitrogen, sediment pigment amount) and food sources ($\delta^{13}C/\delta^{15}N$, pigment composition) (PIs Elisabeth Alve and Silvia Hess, UiO and Paul Renaud, Akvaplan-niva)
4. ***T3-4-4: Sympagic-pelagic-benthic coupling*** by sampling representative benthic invertebrate taxa and demersal fishes for stable carbon and nitrogen stable isotope analysis (PIs Bodil Bluhm, UiT and Lis Jørgensen, IMR, and PD Amanda Ziegler)
5. ***T3-4-4: Sympagic-pelagic-benthic coupling*** by conducting sediment community respiration incubation experiments onboard (PI Paul Renaud, APN, with PD Arunima Sen and PhD student Eric Jorda, Nord Univ.)
6. ***T3-4-4: Sympagic-pelagic-benthic coupling*** by sampling sediment for IP_{25} analysis and biogenic silica as indicators of ice algal food available to the sediment communities (PI Marit Reigstad with PhD student Yasemin Bodur, UiT).
7. ***T3-4-4: Trophic ecology of benthos*** by sampling benthic meiofauna for molecular characterization of diets of small benthic invertebrates (PI Anna Vader, with PhD student Snorre Flo, UNIS/ UiT).
8. ***RF1 T1-3: To help to interpret changes in sea-ice distribution, paleoproductivity, and related environmental conditions during the past 2 kyrs*** by using results gained by living benthic foraminiferal assemblage and associated parameter analyses of surface and sub-surface sediments (PI Elisabeth Alve, with PhD student Thaise Freitas and Silvia Hess, UiO)
9. ***RF2 - T2-1.2 Ocean acidification effects on the mobility of particulate and dissolved organic carbon (POC, DOC), essential trace elements (micronutrients) and heavy metals*** by sampling sediment sub-samples for trace element analysis by sequential sediment extraction (PI Murat Ardelan with PhD Stephen Kohler).

3.7.2 Sampling sites and strategy (RF3 T3-1-1, T3-1-2, T3-4-3 and T3-4-4)

Sampling largely followed the Nansen Legacy sampling protocol version 8. We sampled demersal fish and epibenthos from two locations: a site south of P1, as well as a site between P3 and P4, with ~7-15 min Campelen 1800 trawl hauls. At both stations, a smaller net (6 mm mesh) was added to sample smaller organisms. Bottom trawl sampling at P7, P6, and P5 was not possible due to sea ice appearance. Details on the trawling procedure are described in the fish section of protocol version 8. Benthic organisms were picked from the trawl haul both on deck and in the fish lab, identified to the highest

practical taxonomic resolution, and either frozen (for later stable isotope analysis and wet weight-to-carbon analysis), or fixed in formalin or 70% ethanol (for the museum collection, depending on taxon), or 96% ethanol (to allow later molecular analysis of museum archived specimens).

Sampling for sediment parameters, organismal abundance and diversity was done at stations P1, P2, P4, P6 and P7 using a 50 x 50 x 50 cm giant box core (owned by UiT - Department of Geosciences). At all these sites three box core replicates were taken for further sub-sampling. Sediment cores for respiration experiments were collected at P1, P4, P6 and P7.

3.7.3 Station P1 (1. May 2021)

Three box core replicates were successfully recovered after three deployments. Sediment surfaces of all replicate cores were well preserved, had clear surface water on top and some visible macrofauna (Fig. 3.16). Sediments were light brownish down to 3 cm core depth. Sediments below were gray and stiff. Many long polychaete tubes from Spiochaetopterus were present in all replicate cores. A sediment incubation experiment was set up (see respiration incubation section).

Figure 3.16: Sediment surface of box cores (replicate 1, 2, and 3) at site P1

Microbes were sampled in replicates of three (one per box core) with a 4.7 cm diameter core and sectioned in 1 cm layers up to 6 cm. The center of each section was taken out with a 60 ml syringe and the sediment placed into a sterile whirl pack bag and frozen at -80°C. The rest sediment of each section and the lower part of the sub-core (>6 cm core depth) were stored in separate sterile whirl pack bags and kept in a fridge for on-board single cell extraction by Lise Øverås (UiB).

Benthic foraminifera and multicellular meiofauna were sampled in replicates of three with a 5.5 cm diameter core and sectioned in 1 cm layers up to 6 cm, placed into Joni

containers and preserved with rose Bengal stained 70% ethanol (2g rB per liter) and stored at room temperature.

Sediment grain size, TOC, TN and $d^{13}C$/ $d^{15}N$ samples were sampled in bulk using a 5.5 cm diameter core and sectioned in 1 cm layers up to 6 cm in each of the three replicate cores. Samples were immediately stored at -20°C.

Sediment pigment (chlorophyll a, phaeopigments) samples were taken from a 4.7 cm sub-core sliced down to 6 cm in 1 cm-slices and from there on in 2 cm-slices down to 10 cm core depth. Samples were wrapped in aluminum foil and stored in a -20°C freezer.

To assess pigment composition using HPLC analysis, a single sample from each box core was taken from the 0-2 cm layer using a 60 ml syringe and stored wrapped with aluminum foil at -80°C as part of a collaboration with the CHAOS project in the UK's Changing Arctic Ocean program.

A surface sediment sample (0-1 cm) was taken for IP25 analysis with a 60 ml syringe and stored at -80°C.

One surface scrape each was taken for molecular analysis of diets of selected meiofauna taxa (stored in 96% ethanol at -20°C), and for trace metal analysis from the two firsts replicates. For the third replicate the sample was collected using a 60 ml syringe.

Two spoonsful of the sediment surface were scraped off and placed into 15ml falcon tubes and stored at -20°C for measuring trace metals from each replicate box core.

A single sample from each box core replicate was taken from the 0-3 cm layer using a 60 ml syringe. One-centimeter sections were made and placed into Ziploc bags and stored at -20°C for analysis of biogenic silica.

Twenty sediment cores (11.7 cm inner diameter) were taken from the three box corers (7 from the first 2 and 6 from the third) for incubation and measurement of bulk sediment respiration rates. Four treatments (5 replicates each) were carried out: treatment 1 was at ambient bottom water temperature (1°C), treatment 2 was also at ambient conditions, but isotopically labelled algae was added, treatment 3 was carried out at 4°C above ambient temperature, and treatment 5 was also carried out at the warmer temperature with the algal addition. Control cores with just bottom water were also measured (2 at each temperature). Cores were first acclimated and bubbled to oxygen saturation for 12 hours. 50ml of the water was then collected for measuring nutrients (silica, nitrate, etc.). Afterwards, cores were sealed, and oxygen measurements were taken every 6 hours to measure oxygen consumption rates. Core tops with magnetic stir bars were fixed on, removing air bubbles, and connected to electric transformers to keep the bars stirring in order to avoid stratification of the water in the cores. Oxygen measurements were taken every 6 hours via the *PreSens Fibox* 4 optical sensor system. Experiments were terminated

when 30% oxygen was consumed, upon which 50ml nutrient samples were taken again to measure the rate at which they were released. After incubation, microbe samples were taken from the first three replicates of each treatment (1.5g surface sediment frozen directly at -80°C and 0.1 g surface sediment mixed with 40µl glutaraldehyde and 90 µl phosphate buffered saline solution and frozen at -80°C). From the two treatments where algae were added (treatments 2 and 4), the first 2 cm were sampled via two 60ml cutoff syringes for measuring uptake rates of meiofauna and forams. After taking the microbe and meiofauna samples, the sediment incubation/respiration cores were washed through a 0.5 mm sieve and remaining macrofauna were preserved in 4% formaldehyde seawater and Rose Bengal solution. Sediment cores for respiration incubations were given a UUID through the system, but no labels were generated since these cores did not have a physical form after incubations were terminated. However, macrofauna samples, nutrient samples and meiofauna samples (post-incubations) were taken from these cores and all these samples had UUIDs and appropriate labels, with the parent UUID being the generated, but label-less UUIDs for the incubation cores.

A single multicore liner was inserted into the box core sediment from the first box core for collecting samples for porewater chemistry analysis. Holes were predrilled into the sub core and upon retrieval, porewater was collected via rhizons every 6 cm. 1ml of porewater from every layer was added to 1ml of zinc acetate solution and then frozen at -20°C for measuring sulfide concentrations. The rest of the porewater from each layer was frozen at -20°C for measuring nutrients and DIC. For methane analysis, every 5 cm from sediment surface was collected with a 3ml syringe and added to a NaOH solution and kept cold.

The remaining surface area was sieved through 1 mm mesh and organisms retrieved (mostly polychaetes) were identified to family level where possible and frozen at -20°C for later stable isotope analysis. For future cruises, a 0.5 mm should be used together with a 1 mm in a cascade. For these samples, only sieves that have not been in contact with enriched material (from incubation experiments) were used.

3.7.4 Station P2 (2. May 2021)

Three box core replicates were successfully recovered after three deployments. Sediment surfaces of all replicate cores were well preserved, had clear surface water on top and some visible macrofauna (Fig. 3.17). Sediments were light brownish down to 3 cm core depth. Sediments below were gray and stiff, with a crust layer close to 10 cm.

Figure 3.17: Sediment surface of box cores at site P2, replicate 1 and 2

Six, six and seven sediment cores (11.7 cm inner diameter) were taken from each replicate box core, for macrofauna analyses and sieved immediately (not used for incubation experiments) through 0.5 mm sieve and preserved in 4% formaldehyde seawater solution. The same sampling procedure as P1 was conducted for all other sediment parameters.

3.7.5 Station P4 (6. May 2021)

Three box core replicates were successfully recovered after three deployments. Sediment surfaces of all replicate cores were well preserved, had clear surface water on top and some visible macrofauna (Fig. 3.18). Sediments were light brownish down to 3 cm core depth. Sediments below were gray and stiff. Many long polychaete tubes from Spiochaetopterus were present in all replicate cores. The same sampling procedure as P1 was conducted, including setting up a new incubation experiment was set up. Temperatures were set at 1°C and 5°C for the experiments (based on bottom water conditions).

Figure 3.18: Sediment surface of box cores (replicate 1, 2, and 3) at site P4

3.7.6 Station P6 (11 – 12. May 2021)

Three box core replicates were successfully recovered after three deployments. Sediment surfaces of all replicate cores were well preserved, had clear surface water on top and some visible macrofauna (Fig. 3.19). Sediments were light brownish down to 3 cm core depth. Sediments below were gray and stiff. Sampling was identical to at P1, including setting up a new incubation experiment. Temperatures for experiments were maintained at 0°C (ambient was negative, but negative temperatures were not possible) and 2°C (since deeper water is not expected to experience as much of an increase in temperature as shallower shelf areas).

Figure 3.19: Sediment surface of box cores (replicate 1, 2, and 3) at site P6.

3.7.7 Station P7 (15 – 16. May 2021)

Three box core replicates were successfully recovered after five deployments. Sediment surfaces of all replicate cores were well preserved, had clear surface water on top. Sediments were light brownish down to the bottom of the boxcorer. Sampling was identical to at P1, including setting up a new incubation experiment. Temperatures for experiments were maintained at 0°C (ambient was negative, but negative temperatures were not possible) and 2°C (since deeper water is not expected to experience as much of an increase in temperature as shallower shelf areas).

Figure 3.20 Sediment surface of box cores (replicate 1, 2, and 3) at site P7.

3.7.8 Respiration incubation experiments

Respiration experiments were carried out at all 4 target stations (P1, P4, P6 and P7). In all experiments, treatment 4 (higher temperature and algae added) oxygen consumption rates were higher than other treatments and had to be terminated well before the other treatments. Differences in rates between other treatments and between stations will be examined once all the data is processed.

3.7.9 Macrofauna observations - Epifauna

Trawls were not quantitatively analyzed. However, we noticed some differences in the epifauna collected by the two trawls. *Pandalus borealis* shrimp was highly abundant at the first station between P1 and P2. Overall, this location appeared not to be very diverse. Much higher variety in terms of different types of animals and species were collected during the second trawl north of P2. At this location, *P. borealis* was not abundant, and polar cod made up the majority of the haul. However, we retrieved animals such as the sea cucumber *Molpadia borealis*, polychaetes from the family *Flabelligeridae* (*Brada* sp.), numerous gastropods, including with anemones attached, sea urchins, multiple species of pycnogonids, and even an squids (Rossi asp.). In the trawls between P3 and P4, bascket stars (Gorgoncephalus) and crinoids were collected, together with different kinds of brittle stars. When it comes to box core surface macrofauna, the polychaetes (*Spiochaetopterus typicus*) were present in high numbers at the shelf stations (P1 and P4). In P1 and P2 Lumbirnerid polychaetes were also highly abundant together with Maldanids. At P2 and P4, Thyasirid species dominated when it comes to Molluscs. However, almost no molluscs were observed at P1. The quantity or biomass appeared to be considerably lower at the deeper stations (P6 and P7). At P6 crustaceans appeared to dominate the community instead of polychaetes. Also some crustaceans (amphipods and isopods) were found at the last box core replicate from P7 which was closer to the slope due to drift of the boat. Sibolginid worms, in contrast to previous cruises, were not present at the P7 station, while some tubes were found at P6. Some specimens from the family Yoldiellidae were found at P7 station (some coloration was observed in the gills, maybe an indication of polychaetes dominated.

Table 18: Overview of stations sampled for each of the different activities. Numbers in parentheses indicate number of sediment layers.

				Station / no. of replicates / treatments for incubation						
Sample type	**Task**	**PI/responsible**	**Institution**	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**
Sediment microbes	T3-1-1	L. Øvreås	UiB	3 (6)	3 (6)	-	3 (6)	-	3 (6)	3 (6)
Meiofauna	T3-1-1	E. Alve	UiO	3 (6)	3 (6)	-	3 (6)	-	3 (6)	3 (6)
Macrofauna	T3-1-1	P. Renaud/H. Reiss, E. Jorda	APN / Nord	40	68	-	47	-	52	28
Museum vouchers	T3-1-1	B. Bluhm	UiT	1	-	5		-	-	1
Grain size, d13C/d15N	T3-1-2	E. Alve	UiO	3 (6)	3 (6)	-	3 (6)	-	3 (6)	3 (6)
Sediment phaeopigments	T3-1-2	P. Renaud	APN	3 (8)	3 (8)	-	3 (8)	-	3 (8)	3 (8)
Sediment compositon	T3-1-2	P. Renaud / UK CHAOS	APN	3 (1)	3 (1)	-	3(1)	-	3 (1)	3 (1)
Organisms ☒^{13}C/☒^{15}N	T3-4-4	B. Bluhm / L. Jørgensen	UiT / IMR	20 taxa	34 taxa	-	28 tax	-	22 tax	-
Incubation experiments	T3-4-4	P. Renaud / A. Sen	APN / Nord	20	-	-	20	-	20	20
Nutrients pre-incubations	T3-4-4	P. Renaud / A. Sen	APN / Nord	24	-	-	24	-	24	24
Nutrients post-incubations	T3-4-4	P. Renaud / A. Sen	APN / Nord	24	-	-	24	-	24	24
Sediment IP_{25}	T3-4-4	M. Reigstad / Y. Bodur	UiT	3 (1)	3 (1)	-	3 (1)	-	3 (1)	3 (1)
Meiofauna molecular diet	T3-4-4	A. Vader	UNIS	3 (1)	3 (1)	-	3 (1)	-	3 (1)	3 (1)
Trace metals	RF2	M. Adelan / N. Sanchez	NTNU	3 (1)	3 (1)	-	3 (1)	-	3 (1)	3 (1)
Biogenic silica	T3-4-4	Y. Bodur/ M. Reigstad	UiT	3 (3)	3 (3)	-	3 (3)	-	3 (3)	3 (3)

3.8 Underway surveys

RV Kronprins Haakon is equipped with several underway measurement systems to provide data along the cruise track.

3.8.1 Meteorological measurements from Vaisala AWS430 weather station

Air and sea temperature (8 m depth), air pressure, wind speed and direction, relative humidity and solar radiation is measured continuously by a Vaisala AWS430 weather station.

3.8.2 Thermosalinograph

Temperature, salinity, density and fluorescence is measured from the clean water intake at 4 m depth, and logged from departure Tromsø. The clean water intake is sensitive to ice (filter get clogged) or water at freezing temperature (-1.7), so pumps shut down when we were going in the ice. The alternative inlet at 9 m depth, is located in the sinking keel, that cannot be used in ice covered waters.

4 References

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Appendix

Appendix 1: Cruise participants (name, role/activity/task, affiliation)

Captain: Hallgeir Magne Johansen

Cruiseleader: Martin Ludvigsen (NTNU)
Co-lead: Philipp Assmy (NPI)

Cruise participants. Team(co-) leads in bold.

#	Name*	Institution	RF/RA	Role/Task	Comment
1	Martin Ludvigsen	NTNU	RA-C	Chief scientist	
2	Philipp Assmy	NPI	RF3	Co-chief scientist	
3	**Adam Steer**	NPI	RF1	Sea ice physics	**TL RF1**
4	Tristan Petit	NPI	RF1	Marine optics	
5	Polona Itkin	UiT	RF1	Sea ice physics	
6	Tore Mo Bjørkelund	NTNU	RA-C	Marine robotics	
7	**Jens Einar Bremnes**	NTNU	RA-C	Marine robotics	**TL robotics**
8	**Elizabeth Jones**	IMR	RF2	Chemistry	**TL chemistry**
9	Matthew James Samuel Adams	NTNU	RF2	Chemistry	
10	Stephen Gustav Kohler	NTNU	RF2	Chemistry	
11	Griselda Anglada Ortiz	UiT/CAGE	RF2	Chemistry	
12	**Snorre Flo**	UNIS/UiT	RF3	Microbiology	**TL microbioloy**
13	Marti Amargant	UiT	RF3	Microbiology	
14	Natalie Summers	NTNU	RA-C	Microbiology	
15	**Miriam Marquardt**	UiT	RF3	Microbiology	**TL sea ice biology**
16	Karoline Saubrekka	UiO	RF3	Microbiology	
17	Lasse Olsen	UiB	RF3	Microbiology	
18	Stefan Thiele	UiB	RF3	Microbiology	
19	Yasemin Bodur	UiT	RF3	Vertical flux	
20	Doreen Kohlbach	NPI	RF3	Biomarker	
21	Maja Hatlebakk	NTNU	RF3	Microzooplankton	

22	Christine Gawinski	UiT	RF3	Zooplankton	
23	**Elisabeth Halvorsen**	UiT	RF3	Zooplankton	**TL Zooplankt.**
24	Konrad Karlsson	UNIS	RF2/3	Zooplankton	
25	Robynne Nowicki	UiO/UNIS	RF2	Ecotoxicology	
26	Helene Thorstensen	UiO	RF2	Ecotoxicology	
27	Julia Giebichenstein	UiO	RF2	Ecotoxicology	
28	Thaise Ricardo de Freitas	UiO	RF1/3	Benthos	
29	**Arunima Sen**	Nord	RF2	Benthos	**TL Benthos**
30	Silvia Hess	UiO	RF1/3	Benthos	
31	Eric Jorda Molina	Nord	RF3	Benthos	
32	**Haakon Hop**	NPI	RF2/3	Scientific diving	**TL Diving**
33	Mikko Vihtakari	NPI/IMR	RF3	Scientific diving	
34	Peter Leopold	NPI	RF3	Scientific diving	
35	Amalia Keck	NPI	RF3	Scientific diving	
36	**Rupert Krapp**	NPI		Sea ice safety	**Sea ice safety**

Appendix 2: Station table & cruise timeline

Station table and timeline

From	To	Start Lat	Start Lon	End Lat	EndLong	Depth	DTG	Deployment
Leaving TOS							4/27/2021 20:00	
Tromsø	P1	69.6763	18.9330	76.0000	31.2198	326	4/29/2021 23:15	Transit
P1	NLEG2	76.0000	31.2198	76.5000	31.2210	308	5/1/2021 16:45	
NLEG2	NLEG3	76.5000	31.2210	77.0000	34.0000	154	5/1/2021 22:15	
NLEG3	P2	77.0000	34.0000	77.4986	34.0011	189	5/2/2021 2:30	
P2	NLEG5	77.4986	34.0011	77.9989	33.9998	196	5/3/2021 6:15	
NLEG5	NLEG6	77.9989	33.9998	78.5000	34.0004	180	5/3/2021 12:01	
NLEG6	P3	78.5000	34.0004	78.7498	34.0008	307	5/3/2021 14:53	
NLEG8	NLEG09	78.5000	34.0004	79.2492	34.0018	216	5/4/2021 11:24	
NLEG09	NLEG10	79.2492	34.0018	79.5002	33.9966	300	5/4/2021 15:17	
NLEG10	P4	79.5002	33.9966	79.7494	33.9971	338	5/4/2021 19:16	
P4	NLEG12	79.7494	33.9971	79.9982	33.9961	212	5/7/2021 4:15	
NLEG12	P5	79.9982	33.9961	80.4966	33.9898	163	5/7/2021 11:15	
P5	NLEG14	80.4966	33.9898	81.0018	33.9996	220	5/9/2021 1:19	
NLEG14	NLEG15	81.0018	33.9996	81.3118	31.3503	188	5/9/2021 9:27	

NLEG15	NLEG16	81.3118	31.3503	81.3822	31.2898	186	5/9/2021 11:18	
NLEG16	NLEG17	81.3822	31.2898	81.4110	31.2455	206	5/9/2021 12:40	
NLEG17	NLEG18	81.4110	31.2455	81.4310	31.1448	256	5/9/2021 13:58	
NLEG18	NLEG19	81.4310	31.1448	81.4593	31.0778	496	5/9/2021 15:19	
NLEG19	NLEG20	81.4593	31.0778	81.5025	30.9588	694	5/9/2021 16:53	
NLEG20	P6	81.5025	30.9588	81.5495	31.1605	835	5/9/2021 18:33	
P6	NLEG22	81.5495	31.1605	81.5905	30.7409	1546	5/12/2021 13:26	
NLEG22	NLEG23	81.5905	30.7409	81.6165	30.6529	1950	5/12/2021 15:47	
NLEG23	NLEG24	81.6165	30.6529	81.6830	30.5225	2813	5/12/2021 18:37	
NLEG24	P7	81.6830	30.5225	81.9693	29.6217	3293	5/13/2021 0:53	
P7	LYR	81.9693	29.6217	78.2167	15.6333	10	5/19/2021 12:53	northern route

Station table with location, gear, measurements

Station name	**Location**	**Bottom depth (m)**	**Activities (by gear type)**
Close to P1			CTD w/deep water for sediment trap (Yasmin) & experiments (benthos)
P1	76.000 °N, 31.220 °E	322	CTDs w/ water, plankton nets, optics & GO-FLO casts Sediment traps Box corer (3 successful replicates) Zooplankton nets for sorting & experiments, plankton pump Demersal trawl Pelagic trawl (either P1 or P2) Macrozooplankton trawl USV, AUV
NLEG02-03	77.000 °N, 34.000 °E	154	CTD w/ water (OA & XRF, SEM, BP, FCM) CTD w/deep water for sediment trap (Yasmin) & experiments (benthos) Optics cast at NLEG02
P2	77.500 °N, 34.000 °E	190	CTDs w/water, plankton nets, optics & GO-FLO casts Sediment traps Box corer (3 successful replicates) Zooplankton nets for sorting Demersal trawl Macrozooplankton trawl
NLEG05-06			CTD w/ water (OA & XRF, SEM, BP, FCM) Optics cast at NLEG05
P3	78.750 °N, 34.000 °E	301	*P3 has the lowest priority of the P-stations* CTDs w/water, plankton nets, optics & GO-FLO casts Short sea ice station if sea ice present
NLEG08-10	79.250 °N, 34.000 °E	215	CTD w/ water (OA & XRF, SEM, BP, FCM) CTD w/deep water for sediment trap (Yasmin) & experiments (benthos) Optics cast at NLEG09

P4 (sea ice)	79.750 °N 34.000 °E	332	CTDs w/water, plankton nets, optics & GO-FLO casts Sediment traps Box corer (3 successful replicates) Zooplankton nets for sorting & experiments, plankton pump Sea ice station; potential additional sea ice work close to M2(?) Macrozooplankton trawl if sea ice conditions allow ROV
NLEG12			CTD w/ water (OA & XRF, SEM, BP, FCM) CTD w/ deep water for sediment trap (Yasmin) Optics cast
P5 (sea ice)	80.500 °N 34.000 °E	167	CTDs w/water, plankton nets, optics & GO-FLO casts Sediment traps Zoopankton nets for sorting Sea ice station (including biology) ROV
NLEG14-20			CTD w/ water (OA & XRF, SEM, BP, FCM) CTD w/deep water for sediment trap (Yasmin) & experiments (benthos) Optics cast at NLEG14
P6 (sea ice)	81.546 °N 30.855 °E	865	CTDs w/water, plankton nets, optics & GO-FLO casts Sediment traps Zooplankton nets for sorting Box corer (3 successful replicates) Sea ice station (including biology; 72 h)
NLEG22-24			CTD w/ water (OA & XRF, SEM, BP, FCM) CTD w/deep water for sediment trap (Yasmin) & experiments (benthos) Optics cast at NLEG24
P7 (or other station in deep AO)	82,000 °N 30,000 °E	3000	Standard CTDs, plankton nets, optics & GO-FLO casts Sediment traps Box corer (3 successful replicates) Zooplankton nets for sorting & experiments, plankton pump Sea ice station (including biology; 72 h) ROV

Appendix 3: Datasets

Who		Sample info		Analyses					Relevance to Nansen Legacy implementation plan		Data				
Cruise participant	PI	Sample type	Intended method	Parameter	Analysis protocol	Dataset	Where will analyses be done	When are analyses planned for	RF	Task/Subtask	Sharing within project	Publishing data	Ask for embargo of data?	If yes, why?	Comments
N Summers, S Flo, M Marquardt, Y Bodur	A. Vader	Chlorophyll a	Fluorometric analysis	Chl a total and > 10um biomass	NL v8: 7.13.1	Chl a total and > 10um biomass	Onboard KPH	During cruise	3	T3-1.1	2021	2021	No		
S. Flo, K. Saubrekka	A. Vader/T. M. Gabrielsen	Microbial diversity (DNA and RNA)	rRNA	Protist diversity	NL v8: 7.17	Microbial eukaryote diversity across season based on rRNA metabarcoding	UNIS	2019-20	3	T3-1.1/T3-1.2/T3-1.3/T3.2.1/	2020	2020	No		
S. Flo, K. Saubrekka	A. Vader/T. M. Gabrielsen	Microbial activity (RNA)	mRNA	Protist activity	NL v8: 7.18	Metatranscriptomics and quantification of gene expression	UNIS	2020	3	T3-2.2	2021	2021	No		
S. Flo, E. Jorda, A. Sen, S. Hess, T. Freitas	A. Vader/B. Bluhm/C. Svensen/Kim Præbel	Sediment in ethanol	Box core for analysis /DNA	Benthos diet/prey diversity	NL v8: 10.4.14	Diversity of zoobenthos prey, possibly also genetic identification of benthis species	UNIS/UiT	2022	3	T3-4.2	2021	2021	Yes, possibly	PhD project	
S. Flo	A. Vader/B. Bluhm/C. Svensen/K. Præbel	Small mesozooplankton diet	64 um plankton sample for DNA small mesozooplankton	Zooplankton diet/prey diversity	NL v8: 10.4.14	Diversity of small zooplankton prey, possibly also zooplankton genetic identification	UNIS/UiT	2020-2021	3	T3-4.2	2021	2021	Yes, possibly	PhD project	
Yasemin Bodur	M. Reigstad, Y. Bodur	Chlorophyll a	fractionated algal pigments, from sediment trap samples	Chl a total	NL v8 chapter 8	Chlorophyll a	Onboard KPH	During cruise	RF3	T3-2.2; 4.4	2020	2021	yes	PhD-project	
Y. Bodur	M. Reigstad, Y. Bodur	Chlorophyll a >10µm	fractionated algal pigments, from sediment trap samples	Chl a >10µm	NL v8 chapter 8	Chlorophyll a >10µm	Onboard KPH	During cruise	RF3	T3-2.2; 4.4	2020	2021	yes	PhD-project	
Y. Bodur	M. Reigstad, Y. Bodur	POC/PON	CN analyses from sediment trap samples	µg/L	NL v8 chapter 8	POC/PON	UiT	2019-21	RF3	T3-2.2; 4.4	2020	2021	yes	PhD-project	
Y. Bodur	M. Reigstad, Y. Bodur	stable isotopes	from sediment trap samples	d13C; d14N	NL v8 chapter 8	stable isotopes	UiO	2019-21	RF3	T3-2.2; 4.4	2020	2021	yes	PhD-project	
Y. Bodur	M. Reigstad, Paul Renaud, Y. Bodur	water column pigments	HPLC from sediment trap samples	mg pigment type / m2	NL v8 chapter 8	HPLC	UK	2019-21	RF3	T3-2.2; 4.4	2020	2021	yes	PhD-project	
Y. Bodur	M. Reigstad, P. Renaud, Y. Bodur	sea ice algae proxy	IP25 from sediment trap and boxcore samples	mg pigment type / m2	NL v8 chapter 8	IP25	UK	2019-21	RF3	T3-2.2; 4.4	2020	2021	yes	PhD-project	
Y. Bodur	M. Reigstad, Y. Bodur	phytoplankton communities	from sediment trap samples	community composition and counts	NL v8 chapter 8	phytoplankton communities	UiT	2019-21	RF3	T3-2.2; 4.4	2020	2021	yes	PhD-project	

Y. Bodur	M. Reigstad, Y. Bodur	fecal pellets	from sediment trap samples	fecal pellet types and counts	NL v8 chapter 8	fecal pellets	UiT	2019-21	RF3	T3-2.2; 4.4	2020	2021	yes	PhD-project	
Y. Bodur	M. Reigstad, Y. Bodur	nutrients	from sediment trap samples	nutrients	NL v8 chapter 8	fecal pellets	UiT	2019-21	RF3	T3-2.2; 4.4	2020	2021	yes	PhD-project	
Y. Bodur	M. Reigstad; P. Renaud	particulate biogenic Silica	biogenic silica from sediment trap and boxcore	biogenic silica	NL v8 chapter 8	bSi	UiT	2019-21	RF3	T3-2.2; 4.4	2020	2021	yes	PhD-project	
Y. Bodur	M. Reigstad; P. Renaud	stable isotopes	stable isotopes from bottom water	stable isotopes	NL v8 chapter 8	stable isotopes	UiO	2019-21	RF3	T3-2.2; T3-4.4; T2-1.2	2020	2021	yes	PhD-project	
Y. Bodur, Stefan Thiele	M. Reigstad, L. Øvreås	particle-associated bacterial DNA	filtration for bacterial DNA over 10µm PC filters	metabarcoding, DNA	not established	microbial diveristy	UiB	2021	RF3	T3-2.2,4.4; T3-1.1/T3-1.2/T3-1.3/T3.2.1/	2022	2022	no		
Y. Bodur; Miriam Marquardt	M. Reigstad, Y. Bodur	Metatranscriptomics	DNA/RNA from sediment trap samples	biological diversity & activity on particles	NL v5 chapter 8; chapter 7.15	Metatranscriptomics	UiT/UNIS	2019-21	RF3	T3-2.2; 4.4	2020	2021	yes	PhD-project	
K. Saubrekka	P. Assmy, B. Edvardsen	Fixed water samples from Niskin bottles 6 depths and ice stations	Utermöhl cell counts under the microscope	Cell abundances of protists > 10 µm	NL v8 7.15 + 7.16	Phytoplankton/protist abundance	IOPAS	2021-2022	RF3	T3.1.1	2020 or when ready	2021	No		
K. Saubrekka	B. Edvardsen	Coccolithophores on PC filters	Scanning electron microscoppy (SEM)	taxonomic composition,	NL v8 7.24	Coccolithophore diversity, dynamics and distribution	UiO	2021-2022	RF3	T3.1.1, T3.1.2, T3.2.1	2021-2022	2021-2022	Need to ask PI	PhD-project	Part of K. Saubrekkas thesis.
K. Saubrekka	B. Edvardsen, P. Assmy	Fixed phytoplankton sample (100-0m)	Light and electron microscopy	Protist diversity > 10 µm	NL v8 9.1	Species lists and micrographs	UiO and IOPAS	2021-2022	RF3	T3.1.1	2020-2021	2021	Need to ask Pis	PhD-project	Part of K. Saubrekkas thesis.
K. Saubrekka	B. Edvardsen	Live raw cultures	Monocultures	Protist taxonomy	NL v8 7.25	Cultures and microscopy	UiO	2021-2023	RF3	T3.1.1	2021	2022	Yes	PhD-project	
S. Thiele	G. Bratbak	SEM filter	Scanning electron microscoppy (SEM)	Qualitative analysis of small plankton	NL v8 7.24	Plankton diversity, dynamics and distribution	UiB	2021	RF3	T3.1.1, T3.1.2, T3.2.1	2021-2022	2021-2022	No		Confirm with the PI
S. Thiele	G. Bratbak, J. K. Egge, T. Tsagaraki	XRF filter	X-Ray Fluorescence (XRF)	Concentration of total particulate elements in µM	NL v8 7.11	Concentration of total particulate O, P, Na, Mg, Si, S, Ca, Mn, Fe, Zn (µM)	UiB	2021	RF3	T3.1.1, T3.1.2, T3.2.1	2021-2022	2021-2022	No		Confirm with the PI
S. Thiele	G. Bratbak, R.A. Sandaa	Virus diversity	viruses from natural waters via iron chloride	Virus diversity	NL v8 7.22	Virus diversity across season based on metabarcoding	UiB	2021	RF3	T3.1.1, T3.1.2, T3.2.1	2021-2022	2021-2022	No		Confirm with the PI
L. Olsen	G. Bratbak	Bacterial activity (Radioactively labelled bacteria)	Bacterial production of carbon biomass	Bacterial prod. rate ([2,3,4-3H] leucine) in µgC L-1-d-1	NL v8 7.21	Bacterial production rate	UiB	2021	RF3	T3-2.3/T3-3.1/	2021-2022	2021-2022	No		Confirm with the PI
L. Olsen	G. Bratbak, Aud Larsen	Microbial abundance	Flow cytometry	Planktonic cell per ml	NL v8 7.20	Abundance tables	UiB	2021	RF3	T3.1.1, T3.1.2, T3.2.1	2021-2022	2021-2022	No		Confirm with the PI
L. Olsen	G. Bratbak, Oliver Müller, L. Mork Olsen	Grazer exclusion experiment	Bacterial prod., Flow Cytometry, microbial	diversity, nutrient analysis, microzooplankton diversity	NL v8 7.32.1	Dynamics of lower trophic level food web structure	UiB	2021	RF3	T3-4.1	2021-2022	2021-2022	yes	Postdoc project	Confirm with the PI
J. Giebichenstein, H. S. Thorstensen	K. Borgå	Meso- and Macrozooplankton	stable isotopes, mercury, persistent org. Poll. analyses	food web contaminant biomagnification	NL V5 chapter 13	food web contaminant biomagnification	UiO	2019-2021	RF2	T2-2.1	2021	2022	yes	PhD project	

J. G.stein, H. S. Thorstensen	K. Borgå	In-situ filtration pump	persistent organic pollutant analyses	food web contaminant biomagnification	NL V5 chapter 13	food web contaminant biomagnification	UiO	2019-2021	RF2	T2-2.1	2021	2022	yes	PhD project	
J. G.stein, H. S. Thorstensen	K. Borgå	whole and dissected fishes: muscle, otoliths, stomach	stable isotopes, merc., persistent org. Poll.	food web contaminant biomagnification	NL V5 chapter 13	food web contaminant biomagnification	UiO / NP	2019-2021	RF2	T2-2.1	2021	2022	yes	PhD project	SI analyses will be done at UiO
J. E. Bremnes, T. M.-Bjørkelund	J. E. Bremnes, T. Bjørkelund, M. Ludvigsen	Underwater hyperspectral images of ice and algae	Hyperspectral analysis and photomosaics	Light spectra of reflectance and transmittance	N/A	Transects with hyperspectral line scans	NTNU	2021-2023	RA-C		2021	2023	yes	PhD project	Part of Natalie Summers thesis.
J. E. Bremnes, Tore Mo-Bjørkelund	J. E. Bremnes, T. Mo-Bjørkelund, Martin Ludvigsen	Multibeam echosounder measurements under ice	Ice morphology mapping and simultanuous localization and mapping (SLAM)	Swaths of acoustic travel distances	N/A	Transects with multibeam echosounder measurements	NTNU	2021-2023	RA-C		2021	2023	no		
J. E. Bremnes, T. Mo-Bjørkelund	J. E. Bremnes, T. Bjørkelund, M. Ludvigsen	Irradiance measurements under ice	Hypersp. data; ice transmittance; att. coefficient	Irradiance	N/A	irradiance at different depths and different ice/snow conditions	NTNU / NP	2021-2023	RA-C		2021	2023	yes	PhD project	
D. Kohlbach; P. Assmy; A. Keck	P. Assmy; D. Kohlbach	Fatty acids	HPLC/ fatty acids stable isotopes by GC-c-MS	lipid classes and fatty acids, and carbon stable isotope	NL v8	Fatty acids of POM & main zooplankton taxa		2021	RF3	T3-1.3	2021-2022	2021-2022	Yes	Post doc project	Dataset shared with Ecotox group (see comment for Stable istope)
D. Kohlbach; P. Assmy; A. Keck	P. Assmy; D. Kohlbach	Highly branched isoprenoids (HBIs) NOT IN SAMPLE TYPE LIST	pelagic and ice branched isopr. (IP25, Diene) by GC-MS	Relative abundances of highly branched isoprenoids	NL v8	HBI of POM, main zooplankton taxa & fish		2021	RF3	T3-1.3	2021-2022	2021-2022	Yes	Post doc project	Dataset shared with Ecotox group (see comment for Stable istope)
D. Kohlbach; P. Assmy; A. Keck; J.	P. Assmy; D. Kohlbach	POM, zooplankton & fish stable isotopes	Stable isotopes	bulk d13C; d14N	NL v8	Stable isotopes of POM, main zooplankton taxa & fish	UiO	2021	RF3	T3-1.3	2021-2022	2021-2022	Yes	Post doc project	mesozooplankton, macrozooplankton & fish. (see row 72)
L. Jones	M. Chierici, A. Fransson	Water samples from the CTD	Carbonate chemistry and chemical parameters	dissolved oxygen, pH, dissolved inorg. C., alk., nutrients, d18O	NL v8	dissolved oxygen, pH, dissolved inorganic carbon, alkalinity, nutrients, d18O	IMR/NPI	2021	RF2	T2-1.1	2020	2021	No		Samples taken for post-cruise analysis in 2021
L. Jones	M. Chierici, A. Fransson	Sea ice, snow, brine, under-ice water	Carbonate chemistry and parameters	pH, dissolved inorg.c. carbon, alkalinity, nutrients, d18O	NL v8	pH, dissolved inorganic carbon, alkalinity, nutrients, d18O	IMR/NPI	2021	RF2	T2-1.1	2020	2021	No		Samples taken for post-cruise analysis in 2021
H. Hop, M. Vihtakari, P. Leopold, A. Keck	H. Hop	Under ice mesozooplankton community	Species count and identification	Mesozooplankton abundance & taxonomy	not established	Mesozooplankton community	IOPAN	Not established yet	RF2 or RF3						
H. Hop, M. Vihtakari, P. Leopold, A. Keck	H. Hop	Diver samples		Various	not established	Multiple scientists	Multiple institutions	Up to the respective scientists	-	-	-	-	-	-	
H. Hop, M. Vihtakari, P. Leopold, A. Keck	H. Hop	Log over dives	To provide parent ID for collected samples	-	-	-	-	-	-	-	-	-	-	-	
M. Hatlebakk	M. Hatlebakk	dilution and grazing experiments	Flow Cytometry, nut., phytopL. microzoop. Diversi.,	HPLC, Fluoro.s		Dynamics of lower trophic level food web structure	Onboard KPH and at NTNU	summer 2021	3	T3-3.1 & T3-4.2	2021	2021	Yes, possibly	Postdoc project	

M. Marquardt	M. Marquardt	CTD w/bottles	Niskin overview	Niskin overview	NL v8	Niskin overview	onboard		RF3		during cruise	during cruise			overview available for all onboard
M. Marquardt	M. Marquardt	Kovacs corer	Sea ice core overview	Sea ice core overview/Ice sampling	NL v8-chap 14	Sea ice core overview/Ice sampling	onboard		RF3		during cruise	during cruise			overview available for all onboard
M. Marquardt	M. Reigstad, G. Bratbak	POC/PON	CN analyses	µg/L	NL v8- 7.4	POC/PON	UiT/UiB	2020-2023	RF3		2020-2023	2022-2023	yes	PhD project	Q3 and Q4 data anlaysed
M. Marquardt	M. Marquardt, R. Gradinger, B. Bluhm	Ice meiofauna abundance/taxonomy (from ice cores and slurpgun samples)	Microscopy	Ind/m3; ml/m3	NL 8 ,14.8.5	Ice meiofauna abundance/taxonomy	UiT	2020-2023	RF3		2020-2023	2022	Yes, possibly		Q3 and Q4 data anlaysed
M. Marquardt	M. Marquardt, R. Gradinger	Nutrients from sea ice cores	Nutrient analyzer	µg/L	NL v8	Nutrients	IMR	2020-2023	RF3		2020-2023	2023	No		just a reference measurement
G. Anglada-Ortiz	T. L. Rasmussen	Plankton sample	Ab. and carb. contr. pteropods foraminifera	#/m3 and mg CaCO3/m3	Aen v8	contribution to the carbonate pump	CAGE-UiT (Tromsø)	2021	RF2	T2-1.4	2021	2021-2022	yes	PhD project	
G. Anglada-Ortiz	T. L. Rasmussen	Water sample	Absolute abundance and carbonate contribution from coccolithophores	#/m3 and mg CaCO3/m3	AeN v8	contribution to the carbonate pump	CAGE-UiT (Tromsø)	2021	RF2	T2-1.4	2021	2021-2022	yes	PhD project	
N. Summers	G. Johnsen	Water samples from CTD, water hole and divers	PhytoPam fluorometer, HPLC and Flow cytrometry	Photosynthetic parameters, mg pigmen type	AeN V8	Status of phytoplankton and ice algae rapid light curves with pigm. and cell traits	NTNU	2021-2022	RF1, RAC	T3-1.1/T3-1.2/T3-1.3/T3.2.1/	2021	2021-2023	yes	PhD-project	
N. Summers	G. Johnsen	Ice cores (bottom 3 cm melted in 300mL of water)	PhytoPam, HPLC and Flow cytrometry	Photosynthetic parameters, mg pigmen type	AeN V8	Status of phytoplankton and ice algae rapid light curves with pigm. and cell traits	NTNU	2021-2022	RF1, RAC	T3-1.1/T3-1.2/T3-1.3/T3.2.1/	2021	2021-2023	yes	PhD-project	
R. Nowicki	Ø. Varpe, G. Gabrielsen, K. Borgå, J. Søreide	Zooplankton and fish samples	Bomb calorimetry	Energy density (kJ/g)	Aen v8	Seasonal energetics of zooplankton and fish	UNIS	2021-2022	RF2	T 2-2.5	2021	2021	yes	PhD	
S. Hess, T. Freitas, A. Sen, E. Jorda	P. Renaud	Sediment pigment	Fluorometric analysis	mg Chl a / m2, mg phaeopigment / m2	NL v8	Sediment pigments	APN	2019-2021	3	T3-1.2	2020	2020-2022	No		to be finalized by PI
S. Hess, T. Freitas, A. Sen, E. Jorda	E. Alve & PhD- T. Freitas	Grain size	Laser Diffraction Particle Size Analyzer	(TOC, %), sediment nitrogen (TN, %), d13C (per mil), d15N	NL v8		UiO	2019-2022	1, 3	RF1, RF3 T3-1.2	2020	2021-2022	Yes, possibly	PhD project	to be finalized by PI
S. Hess, T. Freitas, A. Sen, E. Jorda	E. Alve & PhD student- T. Freitas	Meiofauna abundance	Sorting and morphological identification	number of (taxon) / cm2	NL v8	Foraminifera abundance, diversity and metazoan meiofauna abundance,	UiO UiT / IOPAS	2019-2022	1, 3		2020	2021-2022	Yes, possibly	PhD project	
S. Hess, T. Freitas, A. Sen, E. Jorda	P. Renaud	Sediment pigments	HPLC	mg pigment type / m2	NL v8	sediment pigments HPLC	Plymouth Marine Laboratory	2019-2020	RF3, CAO	T3-1.2	2020	2021-2022	no	no embargo	to be finalized by PI
S. Hess, T. Freitas, A. Sen, E. Jorda	H. Reiss, P. Renaud	Macrofauna diversity and abundance	Sorting and morphological identification	number / cm2, diversity indexes, community analysis	NL v8	Macrofauna metazoan macrofauna abundance, , community analysis	Nord/IOPAN	2019-2020	3	T3-1.1, T3-1.2, T3-1.3	2021-2023	2021-2023	Yes, possibly	PhD project	to be finalized by PI
S. Hess, T. Freitas, A. Sen, E. Jorda	L. Øvreås	Microbial diversity (sediment)	Metabarcoding	taxonomic composition, abundance and	NL v8	Microbial eukaryote diversity in sediment across season based on metabarcoding	UiB	2019-2021	RF3	T3-1.1, T3-1.2, T3-1.3, T3-4.1	2021	?	Unsure		to be finalized by L. Øvreås
S. Hess, T. Freitas, A. Sen, E. Jorda	P. Renaud	Sediment community incubations	Sediment community oxygen uptake	oxygen uptake mmol / h	NL v8	oxygen uptake	onboard	2019-2020	RF3	T3-4.3	2019-2020	2020-2021	no	no embargo	

S. Hess, T. Freitas, A. Sen, E. Jorda	B. Bluhm, A. Altenburger	Megafauna taxonomy	Museum archival	Taxonomic voucher inventory of Nansen Legacy fauna	NL v8	Taxonomic voucher inventory of Nansen Legacy fauna collected	UiT Museum	2020-2023	RF3	T3-3.1	n/a	n/a	No	no embargo	Museum archival timeline
S. Hess, T. Freitas, A. Sen, E. Jorda	B. Bluhm, L. Jørgensen	d13C / d15N organisms (mostly benthic)	IRMS coupled to C/N analyser	d13C, d15N	NL v8	Carbon and nitrogen stable isotope composition	UiO (Nansen Legacy agreement?)	2021-2023	RF3	T3-3.4	2022-2023	2023	possibly	Post doc project	
S. Hess, T. Freitas, A. Sen, E. Jorda	P. Renaud, H. Reiss	Nutrient concentrations in incubations	nutrient analyzer	Macronutrient conc. in bottom water incubation	NL v8	Macronutrient concentrations in bottom water before and after incubation	APN	2019-2020	RF3	T3-3.4	2021-2023	2021-2023	no	no embargo	
C. Gawinski	C. Svensen	Productivity O. similis, Mi. norvegica, Paraeuchaeta sp.	Egg hatching experiments	egg production rate, weight specific egg production rate	NL v8 chapter 9.3.3.	spatial and temporal variability of cope. secondary, specific egg rate for production	UiT	2019 - 2022	RF3	T3-2.2	2021	2021-22	yes	PhD project	
C. Gawinski	C. Svensen	C. hyperboreus, C. glacialis, C. finmarchicus	Egg production experiments	egg production rate, weight specific egg production rate	NL v8 chapter 9.3.3.	spatial and temporal variability of copepod secondary production,	UiT	2019 - 2022	RF3	T3-2.2	2021	2021-22	yes	PhD project	
C. Gawinski	C. Svensen	small mesozooplankton	Secondary production	Female:egg ratio, taxonomy and abundance of nauplii	NL v8 chapter 9.3.3.	production, female:egg ratio for copepod production, copepod reproduction in the polar night	UiT	2019 - 2022	RF3	T3-2.2	2021	2021-22	yes	PhD project	
C. Gawinski	C. Svensen	small mesozooplankton	Sorting and morphological identification	taxonomic composition, zooplankton	NL v8 chapter 9.2.1.2	characterization of the mesozooplankton community in relation to hydrography and seasons	UiT	2019 - 2022	RF3	T3-2.2	2021	2021-22	yes	PhD project	
C. Gawinski, Oliver Müller, A. Grytaas	C. Svensen	Grazing experiment of Oithona and Calanus	Bacterial prod., Cytometry, microb. diversity, microzooplankton diversity	Bacterial production, Flow Cytometry, microbial diversity, microzooplankton diversity	Samples will be analyzed at UiB	Influence of Oithona and Calanus on the microbial food web (top down control?), comparison between the two different feeding strategies	UiB	2021	RF3	T3-4.1	2021-2022	2021-2022	yes	PhD project	
C. Gawinski	C. Svensen	stable isotopes	from Oithona	d13C; d14N (species specific?)		Determine trophic position of Oithona	UiO	2019 - 2021	RF3	T3-2.2	2021	2021-22	yes	PhD project	
C. Gawinski	D. Kohlbach	fatty acids	from Oithona	Relative amount of fatty acid		determine the quality of food of Oithona in different seasons	NPI	2019 - 2021	RF3	T3-2.2	2021	2021-22	yes	PhD project	
A. Steer	A. Steer	ANAFI-USA drone	scene reconstruction and analysis	Sea ice and snow surface morphology	None established	RGB aerial photography from a drone platform	Tromsø	2022	RF1	T1-1.2, T1-2.2	during cruise	Q4 2021/2022	no		
A. Steer	A. Steer	Leica Viva GNSS	kinematic precise point positioning	Sea ice drift and rotation	None established	RINEX v2.1 GNSS observations	Tromsø	2021/22	RF1	T1-1.2, T1-2.2	during cruise	Q4 2021/2022	no		
A. Steer	A. Steer	handheld GPS	coarse relative positioning	sea ice drift, relationship of points on sea ice floes	None established	GPX tracks and point marks	Tromsø	2021/22	RF1	T1-1.2, T1-2.2	during cruise	Q4 2021/2022	no		
A. Steer, P. Itkin	S. Gerland	GEM2 electromagnetic sounder	em sounding of snow and ice thickness	combined snow + ice thickness		georeferenced estimates of snow + ice thickness	Tromsø	2021/22	RF1	T1-1.2, T1-2.2	during cruise	Q4 2021/2022	no		
A. Steer, P. Itkin	S. Gerland	Magnaprobe snow depth probe	snow depth observations	snow depth		georeferenced snow depths	Tromsø	2021/22	RF1	T1-1.2, T1-2.2	during cruise	Q4 2021/2022	no		
P. Itkin, A. Steer	P. Itkin	Snow micropenetrometer	profiles of snow hardness	snow structure	None established	georeferenced profiles of snow hardness	Tromsø	2021/22	RF1	T1-1.2, T1-2.2	during cruise	Q4 2021/2022	no		
A. Steer, P. Itkin	S. Gerland	2" kovacs auger	qualitative ridge structure profiles	sea ice ridge structure	None established	Sea ice ridge structure	Tromsø	2021/22	RF1	T1-1.2, T1-2.2	during cruise	Q4 2021/2022	no		

A. Steer, P. Itkin	S. Gerland	Snow pit kit	direct observation of snow structure	snow structure, density, salinity		Snow parameters	Tromsø	2021/22	RF1	T1-1.2, T1-2.2	during cruise	Q4 2021/2022	no		
A. Steer, P. Itkin	S. Gerland	7" Kovacs corer	Density measurement and CT scanning for ice structure	Ice density and structure profiles	None established	Sea ice density and structure	Tromsø, Trondheim	2022	RF1	T1-1.2, T1-2.2	after analysis	2022	no		
P. Itkin, A. Steer	P. Itkin	Snow corer	Snow samples for CT scanning	Snow structure and brine location	None established	Snow structure	Davos	2022	RF1	T1-1.2, T1-2.2	after analysis	2022	no		
A. Steer, P. Itkin	S. Gerland	9cm kovacs corer	ice core analysis	ice core structure and properties	AeNsampling protocol version 08	Sea ice properties	Tromsø	2022	RF1	T1-1.2, T1-2.2	after analysis	2022	no		
P. Itkin	P. Itkin	ship ice radar	image analysis	Local sea ice morphology	None established	regional scale sea ice properties	Tromsø	2022	RF1	T1-1.2, T1-2.2		2022	no		
A. Steer, P. Itkin	S. Gerland	ASSIST observation protocol	recording observations	Regional sea ice properties	AeN protocol version 08	Ice core	Tromsø	2022	RF1	T1-1.2, T1-2.2		2022	no		
A. Steer, P. Itkin	S. Gerland	RBR handheld CTD	ctd profile analysis	under ice conductivity	None established	CTD profiles	Tromsø	2022	RF1	T1-1.2, T1-2.2	after analysis	2022	no		
A. Steer, P. Itkin	D. Divine, M. Johanssen	Radarsat-2 and Terrasar-X SAR imagery	image analysis	Regional sea ice properties	None established	high resolution SAR imagery	Tromsø	2022	RF1	T1-1.2, T1-2.2	after analysis	2022	yes		
S. Kohler, M. J.S. Adams	N. Sanchez, M. V. Ardelan	Total trace elements and dissolved trace elements	Preconcentration via SeaFAST and ICP-MS	Concentration of elements in nM	NL v7 7.7	Total and dissolved trace elements transect profile	NTNU	2021-2022	RF2	T2-2.2	2021	2022	Need to ask PI		Confirm with the PI
S. Kohler, M. J.S. Adams	M. Digernes, M. V. Ardelan	Dissolved organic matter characterization, DOC	Orbitrap, HPLC-MS	Type and composition of DOM, DOC, ancillary	NL v7, 7.6	Variation, composition, and distribution of DOM and DOC, with ancillary POC	NTNU	2021-2022	RF2	T2-2.2	2021	2022	yes	phd project	M. Digernes PhD project
S. Kohler, M. J.S. Adams	S. Kohler, M. V. Ardelan	Total mercury and methylmercury	(CVAFS) for THg and MeHg, or GC-SF-IR-ICPMS	THg, MeHg in pM	NL v7, 7.7.1	Total mercury and methylmercury transect profile	Mediterranean Inst. of Ocean. (MiO)	2021	RF2	T2-2.2	2021	2022	yes	PhD project	S. Kohler PhD project
S. Kohler, M. J.S. Adams	S. Kohler, M. V. Ardelan	Sediment samples	Sequential extraction for trace elements	THg in ng/g, Trace element concentrations	Nansen Legacy v4 10.4	Distribution of trace elements in sediments	NTNU	2021	RF2	T2-2.2	2022	2022	maybe, check with PI	PhD project	S. Kohler PhD project
S. Kohler, M. J.S. Adams	S. Kohler, M. Digernes, M. V. Ardelan	Hg transformation under different DOM regimes	GC-SF-ICP-MS and CVAFS for Hg, Q-TOF or Orbitrap	Hg in pM, DOM characterization	not established	Hg transformation under different DOM regimes	NTNU	2021-2023	RF2	T2-2.2	2022	2022	yes	PhD project	
S. Kohler, M. J.S. Adams	N. Sanchez, M. V. Ardelan	PFe quota for phytoplankton	Ultraclave digestion and ICPMS	Fe quota in phytoplankton	not established	Fe quota in phytoplankton	NTNU	2021-2023	RF2	T2-2.2	2022	2022	Need to ask PI		Confirm with the PI
E. Halvorsen	E. Bagøien, Post Doc	Macrozooplankton	morphological identification, metabarcoding	taxonomic composition, biomass	NL v5 7.11.1	Key organims, e.g. Euphausiids and amphipods, Map spatial distribution, taxonomic	IMR	2019-2021	RF3	T3-1.1; T3-2.1	2020	2020-2022	No		to be finalized by PI
E. Halvorsen	A. Wold; J. Søreide S. Majaneva	Gelatinous zooplankton	Genetic analyses, counts, size measurmnts	species list; ind/m3; ml/m3	NL v5 9.1.1.6	Gelatinous zooplankton abundance (ind/m3), volume & species composition (species list)	NTNU (S. Majaneva)	2021	RF3	T3-1.1 & 2.1 T3-2.1 & 2.2	2021-2022	2021-2022	Yes	master student	
E. Halvorsen	C. Svensen (UiT)	Small mesozooplankton taxonomy	Taxonomy, abundance	zooplankton abundance ind/m3; biomass (mg C/m3)	NL v8 9.2.1.1	Provide information on small mesozooplankton abundance and vertical distribution	IOPAN	2021-2023	RF3	T3-1.1	2022-2023				

E. Halvorsen	A. Wold/J. Søreide (UNIS)	Mesozooplankton taxonomy	Taxonomy, abundance	zooplankton abundance ind/m3; biomass (mg C/m3)	NL v8 9.2.1.1	Provide information on mesozooplankton abundance and vertical distribution	IOPAN	2021-2023	RF3	T3-1.1	2022-2023				
E. Halvorsen	K. Præbel (UiT)	Small mesozooplankton metabarcoding	Metabarcoding	Molecular species diversity and relative abundance	NL v8 9.2.1.3	Provide information seasonal, annual and regional variations in genetic composition	UiT/BFE	2021-2023	RF3	T3-1					
E. Halvorsen	K. Præbel (UiT)	Mesozooplankton metabarcoding,	Metabarcoding	Molecular species diversity and relative abundance	NL v8 9.2.1.3		UiT/BFE	2021-2023	RF3	T3-1					
E. Halvorsen	J. Søreide (UNIS)	Small mesozooplankton biomass	Dry weight	Zooplankton biomass	NL v8 9.2.1.3		UNIS	2021-2023	RF3	T3-1					
E. Halvorsen	J. Søreide (UNIS)	Mesozooplankton biomass	Dry weight	Zooplankton biomass	NL v8 9.2.1.3		UNIS	2021-2023	RF3	T3-1					
E. Halvorsen	J. Søreide (UNIS)	Small mesozooplankton taxonomy	Taxonomy, abundance, staining	community/mortality	NL v8 9.2.1.3		IOPAN	2021-2023	RF3	T3-1					
E. Halvorsen	J. Søreide (UNIS)	Mesoozooplankton taxonomy	Taxonomy, abundance, staining	community/mortality	NL v8 9.2.1.3		IOPAN	2021-2023	RF3	T3-1					
K. Karlsson	J. Søreide (UNIS)	respiration, grazing, egg production	experiments	respiration, grazing, egg production	NL v8 9..	respiration, grazing, egg production	UNIS	2021-2023	RF3						
M. Amargant-Arumí	R. Gradinger	Radioactively labelled algae on GF/F filters	Primary production in situ incubations	Primary production rate (14C uptake)	NL v6 7.26	Vertical profiles of primary roduction across latitude and seasons	UiT	2019-2020	RF3	T3-1.1/T3-1.2/T3-1.3/T3.2.1/	2020	2021-2022	Yes	PhD-project	
M. Amargant-Arumí	R. Gradinger	Radioactively labelled algae on GF/F filters	Light intensity vs. Photosynthesis curves	Primary production rate (14C uptake)	NL v6 7.27	Primary production response to various light intensitites	UiT	2019-2020	RF3	T3-1.1/T3-1.2/T3-1.3/T3.2.1/	2020	2021-2022	Yes	PhD-project	
M. Amargant-Arumí	R. Gradinger	Isotopically labelled algae on GF/F filters	Nitrogen uptake in situ incubations	d13C, d15N	TBD	Ratios of Carbon and Nitrogen stable isotopes before and after incubations, F-ratios of primary production	?	2019-2020	RF3	T3-1.1/T3-1.2/T3-1.3/T3.2.1/	2020	2021-2022	Yes	PhD-project	

Appendix 4: Overview over blogs and other outreach

Date	Title	URL (English version)
27. April 2021	Våren – et biologisk kritisk vindu i Arktis	https://sciencenorway.no/blog-environment-nansen-legacy-project-blog/spring-a-biologically-critical-time-window-in-the-arctic/1851123
04. May 2021	Våren ligger i lufta	https://sciencenorway.no/blog-nansen-legacy-project-blog-researchers-zone/mixing-production-deep-into-the-ocean/1855474
10. May 2021	Dykkere på vårtokt	https://sciencenorway.no/blog-environment-nansen-legacy-project-blog/nansen-legacy-q2-scientific-divers-sample-ice-algae-and-zooplankton-below-sea-ice/1859564
14. May 2021	På tide med litt skittsnakk	https://sciencenorway.no/blog-nansen-legacy-project-blog-researchers-zone/lets-talk-dirty/1861137
20. May 2021	Det dype mørkeblå havet i Arktis	https://sciencenorway.no/arctic-ocean-blog-marine-biology/the-deep-blue-arctic-ocean-a-scientific-divers-tales-of-life-under-water/1864221
26. May 2021	I fotsporene til Nansen	https://sciencenorway.no/blog-nansen-legacy-project-blog-researchers-zone/in-the-footsteps-of-nansen/1867316
27. May 2021	Alger på vei ned dypet i Polhavet	https://sciencenorway.no/blog-nansen-legacy-project-blog-researchers-zone/algae-sinking-into-the-abyss-of-the-arctic-ocean/1883668

The Nansen Legacy in numbers

6 years

The Nansen Legacy is a six-year project, running from 2018 to 2023.

1 400 000 km² of sea

The Nansen Legacy investigates the physical and biological environment of the northern Barents Sea and adjacent Arctic Ocean.

>10 fields

The Nansen Legacy includes scientists from the fields of biology, chemistry, climate research, ecosystem modelling, ecotoxicology, geology, ice physics, meteorology, observational technology, and physical oceanography.

>350 days at sea

The Nansen Legacy will conduct 15 scientific cruises and spend more than 350 days in the northern Barents Sea and adjacent Arctic Ocean between 2018 and 2022. Most of these cruises are conducted on the new Norwegian research icebreaker RV *Kronprins Haakon*.

280 people

There are about 230 researchers working with the Nansen Legacy, of which 73 are early career scientists. In addition, 50 persons are involved as technicians, project coordinators, communication advisers and board members.

10 institutions

The Nansen Legacy unites the complimentary scientific expertise of ten Norwegian institutions dedicated to Arctic research.

Norwegian Meteorological Institute

UNIS
The University Centre in Svalbard

NERSC

NTNU

Akvaplan niva

50/50 financing

The Nansen Legacy has a total budget of 740 million NOK. Half the budget comes from the consortiums' own funding, while the other half is provided by the Research Council of Norway and the Ministry of Education and Research.

Norwegian Ministry of Education and Research

With funding from The Research Council of Norway

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nansenlegacy

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Photo cover: Martin Ludvigsen